THE TELEGRAPHIC JOURNAL AND

Electrical Review.

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ELECTRICAL RAILWAYS.

Now that a Bill has been passed by a select committee of the House of Commons authorising the incorporation of a company for the construction of an electrical railway from Charing Cross to Waterloo, we may safely assume that we shall shortly see the forerunner of what is likely to become the general mode of travelling, at least for underground lines. More than twenty years ago, and before our present underground railway system came into operation, pneumatic railways were thought to be specially adapted for underground locomotion, whether for passengers or parcels; and after experiments which in those days were of a successful character, the railway between the General Post Office and Euston Square Station (with a central depôt in High Holborn) was constructed. This was intended for parcels traffic, and would probably have succeeded in its objects had not its operations been suspended for about ten years. During this time the Metropolitan line was completed, and although efforts were again made about 1870 and for a year or two afterwards with a view of once more bringing the pneumatic railway to the fore, it was abandoned altogether after about six months of regular work in conveying letters for the postal authorities and parcels of the ordinary kind for the public between the before-mentioned places. The length of this railway was about 2¾ miles, and the whole journey, including changing lines at Holborn, was usually accomplished in nine minutes or so. The iron tubes composing the tunnel were 4 feet high and 4½ feet across, the shape being that of a D placed on its flat side; and the carriages were large enough for the conveyance of passengers. The method of working was somewhat analogous to that which must be employed on an electrical railway. A stationary engine at the central station produced the power necessary to drive a large fan for compressing and exhausting the air in the tubes, and electricity will likewise be produced by stationary engine power. Pneumatic railways are however not to be compared with those employing electricity, for experiment has proved that these latter can be both easily and economically worked, and that the results obtained for power expended are far in advance of what can be produced by air pressure. The locomotive driven by steam as now employed has necessarily to be of enormous weight, as compared with a carriage full of passengers, and in fact it weighs as much in itself as six or seven ordinary carriages with their complement of travellers. Such a heavy mass requires, independently of anything behind it, a considerable expenditure of power to propel it, and in an electrical train such a requirement as a locomotive will be unnecessary, as each carriage may be made its own propeller. Professors Ayrton and Perry have shown that an electro-motor having a dead weight of 50 lbs. can be made to produce 1 horse-power. Now taking the weight of a passenger locomotive at 30 tons, such a mass made up of electro-motors could produce a total of 1,344 horse-power. The same authorities also stated in their admirable lecture at the Royal Institution on March 24th, that to keep up a speed of 40 miles an hour with ten carriages full of people on a level straight line without any locomotive an expenditure of about 90 horse-power would be required. Therefore with the additional weight to these ten carriages of a little more than two tons in electro-motors we should be able to produce the necessary power for propelling such a train, with the current produced at a fixed centre. The most important conditions involved in an electrical railway scheme are those of selecting the best motors, and securing good insulation. This latter question appears to be satisfactorily solved, as far as one can judge without trials, by the methods proposed by Messrs. Ayrton and Perry, which consists in dividing up the line of rails into sections of certain lengths, so that leakage can only take place on one section at a time instead of over the whole line. Perhaps the perfect immunity from danger of collision is the most admirable part of the Professors' system. When we hear of an accident on our ordinary railroads we are apt to make disparaging remarks on the management of certain lines; but we ought rather to express surprise at the very fewness of railway accidents of a serious nature, considering the enormous traffic carried on, and also the fact that we are dependent on human aid for the safe conduct of our trains and their living freights. By the employment of such an electrical railway as that so ingeniously worked out by Messrs. Ayrton and Perry a collision becomes impossible, and their claim for an absolute automatic block is therefore quite allowable. The advantages of such a method of working trains in the Metropolitan tunnels need scarcely be commented on, and it is therefore only necessary to say that all the inconveniences which now militate against the advantages offered to travellers for quick transport from their homes to business would be entirely done away with. We therefore wish the proposed scheme for constructing a railway under the Thames every success, and we do not doubt its prosperity financially any more than we should be dubious as to its practicability, about which we have proofs of too satisfactory a nature to question its future employment as a means of locomotion.

Just at this moment, too, we observe that Dr. Siemens has been making new and successful experiments in Berlin, which should give every confidence to the promoters of the new enterprise. On Saturday last a trial trip was made with Dr. Werner Siemens' improved electrical apparatus and new carriages, on the tramway from Charlottenburg to the Spandauer Bock, in the western outskirts of Berlin. The electric car had to overcome a rising gradient of 1 in 30. For half a mile the line has on leaving the suburb of Charlottenburg to ascend a hill, and here the speed was maintained at ten to twelve kilometres, or about seven miles an hour. Once on the top of the Spandauer Berg, the line is on a level, and here the cars attained a speed of between sixteen and twenty kilometres, or an average of eleven miles an hour. The cables conveying the electric current are fixed on poles above the tramway. On these two insulated cables, which are about nine inches apart, a tiny carriage runs, carried by eight wheels, those on the right being insulated from those on the left. A thin cable unites this carriage with the passenger car below, and the two wires it contains transmit electricity from the two cables above to the dynamo, which is fixed to the bottom

of the car. On the top of the hill is a small house, where the steam engine is situated which generates the electromotive force. Electricians in Berlin are apparently of the opinion that the problem of adapting electricity for locomotive purposes is completely solved, and Dr. Siemens is certainly entitled to every praise for his indefatigable efforts in this direction extending as they have over several years.

REVIEWS.

Information about Lightning Conductors. Issued by the Academy of Sciences of France. Translated by RICHARD ANDERSON, F.C.S., F.G.S. London: E. and F. N. Spon, Charing Cross.

THE most modern portion of the original of this work is not of a later date than 1868, and on that account it might perhaps be considered to be too antiquated to be worth translating; but the information which has been gained about lightning conductors within the last twenty years or so is practically so very little that a work on the subject dating back to 1868 is by no means to be considered as obsolete. The "Information" issued by the Academy of Sciences, although well known by name in this country, has never been properly appreciated, and we think, therefore, that Mr. Anderson has done good service in making the translation. The work, as is pointed out in the Preface, shows that the French Government are in the constant habit of consulting the Académie des Sciences on the subject of protecting buildings from lightning. The British Government, it is also pointed out, in scarcely any instance have done such a thing.

The Action of Lightning, and the Means of Defending Life and Property from its Effects. By ARTHUR PARNELL, Major in the Corps of Royal Engineers. London: Crosby Lockwood and Co.

ALTHOUGH the literature on lightning conductors would form a nucleus to a fair-sized library, certainly as regards this country it might almost never have been written, for we very much doubt whether one in ten thousand of the conductors erected have been the result of information gleaned from books on the subject. We suppose, however, that there must be some demand for such works, otherwise their issue from time to time can hardly be accounted for.

The object of Major Parnell's book is to show how best to protect property from lightning, and in order to enable this to be done (we presume) as effectually as possible, the not uncommon but most absurd practice is followed of inserting a certain quantity of matter which is as useless as it can well be, except to show that the author has studied and is acquainted with the theory of electrical action. Thus on page 3 we have given the well-known formula for the "Derived Mechanical Units" and the "Electrostatic System of Units," &c. We shall not be surprised next at seeing a work on "Practical Carpentry" in which it is implied that it is very necessary that an apprentice should study and be well acquainted with all the dynamical formulæ before he can attempt to drive a nail into a piece of wood.

Several pages of the first and second parts of Major Parnell's work contain matter which, without a previous knowledge of electricity, would be utterly incomprehensible to the reader, and which, to those who have studied the latter subject, would be utterly useless, as it is merely a repetition of what is found in any recent text-book on electricity. It really is astonishing that writers can delude themselves into the idea that they are rendering service to any one by inserting such information. The object of the book, as we have before stated, is to show how best to protect property from lightning; but readers will be somewhat startled to find that the system recommended is an entirely new one, and based on a theory propounded by Major Parnell. This gentleman has come to the conclusion that lightning rods are a mistake, and so far from affording protection are actually the causes of damage to buildings. Thus, on page 264, the following paragraph occurs:—"According to our views, then, there is no sound foundation for the existence of the stalks of lightning rods, and their presence is an unmixed source of danger and expense"!!! The new form of protector proposed is called by the inventor an "electric tap." "It consists in its complete form of a plate of iron laid in the ground a few inches below the surface surrounding the building, close either to the walls or the kerb of any pavement, . . . and presenting slightly above the surface of the ground numerous sharp points." The author considers that the action of lightning takes place from the ground upwards, and not downwards from the clouds, according to the general idea.

Major Parnell's theories, though ingenious, will, we think, hardly recommend themselves to the scientific world, and his book, although it contains a carefully compiled series of facts both in favour of and also against his opinions, will scarcely upset the established order of things.

Le Téléphone. By LE COMTE TH. DU MONCEL. Librairie Hachette et Cie., 79, Boulevard Saint Germain, Paris.

ANY work from the pen of the Comte du Moncel is welcome, and this last edition of "Le Téléphone," his most recent production, is the only complete record up to date which exists on the subject treated of. No pains have been spared to give every information possible, and every source from which facts could be obtained has been made use of, due acknowledgment being given of the authority.

The Telephone in Principle and Practice: its Origin and Development. By J. L. K. David Bogue, 3, St. Martin's Place.

THIS is a small pamphlet of 40 pages, and is intended for the general reader. It is written in an entertaining style, and will afford a good spare quarter of an hour's amusement to any one at all interested in telephones.

THE JONES SEXTUPLEX.

ONCE having passed from the transmission of one message to two messages upon a single wire between distant cities, and again from two to four and from four to five, it may appear to be an easy step from five to six, and so on *ad infinitum;* but to the initiated the difficulties increase as the cube of the number of transmissions sought, and these difficulties only become vexatious in the transition of the system from theory to practice. There is nothing particularly new in the idea of multiple telegraphy, as it was fully discussed and cleverly attempted nearly thirty years ago, and all present attainments are founded on old principles.

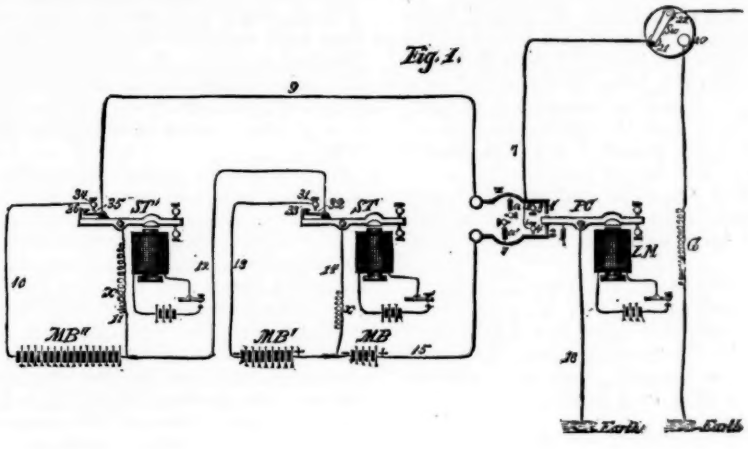
Assuming the readers of *The Operator* to be familiar with the modern duplex and quadruplex systems, it will be proper to outline the principle of Mr. F. W. Jones' ingenious sextuplex system, by which three messages may be transmitted in one direction simultaneously with three messages in the opposite direction over one telegraph wire. But a brief inspection of the accompanying diagram will show that in order to raise the value of a quadruplex to a sextuplex, it was necessary to invent an entirely new quadruplex, to be operated by *straight* or *unreversing* currents, and to this system the addition of the Siemens polarised relay and ordinary pole-changing keys would render possible the six message transmissions before stated. Hitherto no perfect quadruplex system actuated by straight currents has been invented, excepting one just patented by Mr. Jones. We understand that that system opens its local sounders on the front local contacts. In the sextuplex, however, it will be seen that all the local circuits open and close on the back contacts, in order to prevent a mutilation of signals when reversing the main currents.

Fig. 1 represents the transmitting-keys, batteries, and circuit connections necessary for the transmitting end of the line. Fig. 2 represents the main line relays, local relays, local sounders, circuit connections, and devices employed at the receiving end of the line.

As shown in fig. 1, P C is a pole-changing key by means of which main-line batteries, M B, M B′, M B″, are connected to line and earth, and through the agency of which the poles of the batteries may be reversed in respect to the line and earth. *z* and *y* are springs tending to rest upon stops 3 and 4. Main line 7 is joined to stops 3 and 4 by wires 5 and 6. Key P C is connected to earth through 16.

S T and S T′ are ordinary continuity-preserving keys, by means of which batteries, M B′ and M B″, normally cut out, may be put in main-line circuit by closing the keys.

Fig. 1.



Transmitting-keys, S T and S T′, are located upon a fragment of the main-line circuit, having its ends connected with the springs *z* and *y* of key P C, and this fragment consists of conductor 15, battery M B, and branches 13 or 14, transmitting-key S T, conductor 12, branches 10 or 11, key, S T′, and conductor, 9. By operation of the pole-changing key, P C, the opposite ends of this fragment of main-line conductor are alternately reversed from line to earth and earth to line, and *vice versâ*.

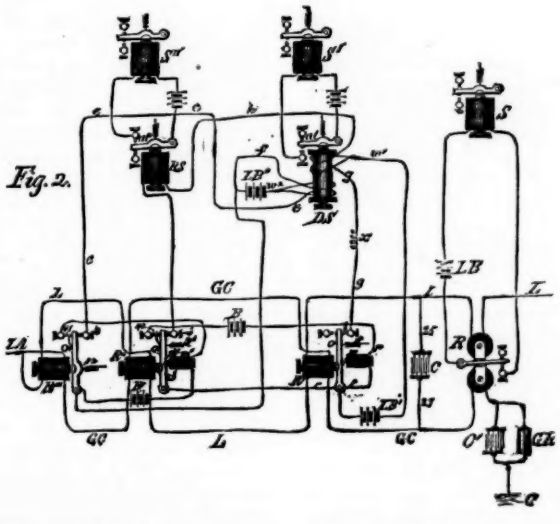
It will be observed that the keys S T and S T′ are situated at different positions in the length of one conductor, and that the fragment of the main line containing these transmitting-keys has only a single earth-connection, 16. When key S T is open, battery M B is closed to line through wire 14, containing resistance *x*. When S T is closed, M B is connected to line through battery M B′, 13, 31, and 12. When S T′ is open, M B and M B′ are joined to line through resistance *x′* of 11, key S T′, 36 and 35. If S T′ be closed, the main-line circuit will not be closed through *x′*, but through M B″, 10, 34, 35, and 9. Resistances *x* and *x′* are made equal respectively to the resistances of batteries M B′ and M B″, since both incoming and outgoing currents will traverse either resistances, *x x′*, or batteries M B′, M B″, according to the positions of keys S T and S T′.

M B is a weak battery, whose relative strength may be represented by 1. M B′ is a stronger battery, whose strength is 2, and M B″ is of strength 4. By reversing currents upon the line a polarised armature at the receiving station is operated.

M B′ and M B″ are added in circuit by closing keys S T and S T′, to increase the strength of current of M B. When keys S T and S T′ are closed, M B′ and M B″, as well as M B, are reversed upon the line by operating P C. The severa current strengths upon the line are, normally, strength—1; key S T closed, S T′ open, strength—3; key S T open, S T′ closed, strength—5; key S T closed, S T′ closed, strength—7. When P C is closed the currents are respectively + 1, + 3, + 5, + 7.

It will be seen from this description that the key system enables eight different conditions of current to be sent to line, and that the battery-sections and resistances are so arranged that a circuit of constant resistance is always provided for all incoming and outgoing currents.

Fig. 2.



S W is a switch by means of which the key system may be disconnected and the line put to earth through resistance G, equal to resistance of the key system, whereby the distant relays may be conveniently balanced.

In fig. 2, which represents the receiving apparatus, R is a polarised relay controlling local sounder, S. Relay, R, responds to a reversal of current strength of 1. It will also respond as well to a reversal of current of strengths 3, 5, or 7. Thus sounder S will respond while strong currents operate the neutral relays for independent signals. R is the first main-line neutral relay, and is operated by a current of either

polarity of strength 3 or currents from M B and M B′ jointly. R″ is the second neutral relay, and will respond to currents of either polarity of strength 5 or currents from M B and M B″ jointly. R‴ is the third neutral relay, which will respond to either polarity of current of strength 7 or current from M B, M B′, M B″, jointly. S′ is the second local sounder, which is to be brought into action by key S T. The local circuit of S′ is opened and closed through the agency of the double differential local relay, D S.

Relay, D S, is differentially wound with the two branches, *h* and *g*, of wire, *w′*, leading from one pole of local battery, L B¹. Branch *h* is connected to the back stop of relay R′, and branch *g* is connected to back stop of relay R′, while armature levers, *o′* and *o″*, of R′ and R″, are joined to the opposite pole of L B′. Relay, D S, is also differentially wound with branches *f* and *e* from wire joined to one pole of local battery, L B″. Branch *e* is carried to back stop, *k*, of relay, R‴, from which connection is made through the armature *o‴* to the opposite pole of L B″. Branch *f* is also connected with branch *e* to the same local battery pole.

It will be observed that the third local sounder is controlled by relay, R S, placed in the branch *h* forming one coil of the first differential set of coils upon double differential relay, D S.

Coils *g* and *h* are oppositely-wound differential coils connected with the poles of local battery, L B′. Thus when both branches are closed the magnetic effects in D S due to L B′ are neutral. Also, *f* and *e* are oppositely-wound differential coils connected with local battery, L B″, and magnetic effects in D S due to L B when both *e* and *f* are closed are neutral.

The operation of local sounders, S′ and S″, may now be explained. Normally the four branches, *e*, *f*, *g*, and *h*, of the double differential windings upon D S are closed and no magnetism is developed to attract armature lever, *a l*; but if a strength of current 3 be sent to line of either polarity the neutral relay, R′, responds and lever, *o′*, is withdrawn from back stop, *i*, and the branch, *g*, is broken, and D S will be subject to the action of the remaining three coils, *e*, *f*, and *h*. Coils *e* and *f* neutralise each other; but coil *h* develops magnetism and armature lever, *a l*, closes the local circuit of sounder, S′. However, when a current of strength 5 is sent to line, not only will armature of R′ be moved and branch *g* be broken, but armature of second neutral relay, R″, will cause *o″* to be drawn from back contact, *j*, to break branch *h*. When branches *g* and *h* are both broken, relay D S is subject only to the effects of differential coils *e* and *f*, which are neutral. Therefore, armature lever *a l* will not close the local of second local sounder, S′. A current strength of 3 is sufficient to break one of four differential branches of D S to destroy magnetic equilibrium, while a current strength of 5 operates to break two branches, and thus re-establish magnetic equilibrium; but while the breaking of *h* establishes magnetic equilibrium in D S to leave S′ unaffected, the breaking of branch *h* demagnetises R S, and *a l* moves to its back stop to close the local of *s″* to give a signal upon the third local sounder. Again, when a current due to the joint action of all the batteries or of strength 7 is sent to line, both local sounders, S′ and S″, should operate. When current 7 of either polarity is sent to line, armature levers of all the local relays, R′, R″, and R‴, are withdrawn from their back stops, and three of the differential branches, *e*, *g*, and *h*, of D S will be broken, and branch *f* will alone remain closed, when again the magnetic equilibrium of D S will be destroyed, and *a l* will close the local of *s′* to give a signal; also, as *h* is broken at the same time, S″ will simultaneously respond.

In winding the double differential relay with its four coils in branches, *e*, *f*, *g*, and *h*, it is apparent that coils of branches, *f* and *g*, must each be wound and connected to their batteries in such a manner that they may each tend to polarise D S alike; that is, if *f* causes a north magnetic pole in the upper part of D S, *h* likewise should be wound to induce a coincident north pole in the upper part of D S. Should *f* and *h* induce opposite magnetic polarities in D S at certain times, a reversal of polarity in D S would occur. For example, if all the branches but *f* were broken, D S would be charged by *f*. Therefore, if *f* induce a north pole in the upper part, and a south pole in the lower part, this polarity would be wholly reversed when *g* alone is broken, as at such time *e* and *f* neutralise each other, and magnetic effects in D S would be due to *h* alone. When key, S T, alone is operated, magnetism in D S is wholly due to coils of branch, *h*. When both keys, S T, and S T,′ are operated, magnetism in D S is wholly due to coil in branch *f*. Therefore to avoid a reversal of magnetic polarity in core of D S, coils of branches, *f* and *h*, must both induce in each end of D S magnetism of the same polarity. If both keys, S T and S T′, are closed to operate both sounders, S′ and S″, relay, D S, will have a given magnetic polarity. If now, key S T′ be opened, the polarity of D S will not be reversed, nor will its magnetic strength even be reduced, and no flutter of armature-bar, *a l*, will occur to mutilate signals upon S′. Armature-levers of R′, R″, and R‴, all close the local sounder-circuits upon their back contacts. Thus when the armature-levers are attracted, a reversal of line current that would reverse the magnetic polarity of R′, R″, or R‴, would occur too rapidly to permit the armature-levers to close one back contact, even if they were to move back slightly from the poles of the relays.

To still further obviate all possible difficulty from the momentary release of the relay armatures upon reversal of current, there is introduced between relays R and R′, condenser C, which is joined by conductors 25 and 27, respectively, to main line, L, and artificial circuit, G C. If a current from line passes over L A to G‴, it will charge condenser C in such a manner, that when the line-current is broken, the condenser will discharge and effect a continuation of the previously broken current up to the time that a reverse current is sent over the line, thus filling the gap in the current at the moment of reversal. The discharge of the condenser occurs through the circuit 25, L to L A, thence over, G C and 27 back to condenser C. This device however, is covered in Mr. Jones's patent No. 191,439 of 1877.

A further part of the invention consists in employing local magnets, *m* and *m′*, with relays R′ and R″. Armature of relay, R¹, is obliged to act under three different strengths of current.

It is desirable that a definite ratio be established between the attractive and retractile forces upon a relay armature. If the current be strong, the tension of the retractile spring should be adjusted high. Thus, if the retracting spring of relay R′ be adjusted for a current strength of 3, its adjustment would be wrong for a current strength of 5 or 7—that is, the tension of the retractor would be too low.

To compensate for a high strength of current a local circuit is caused to be closed by the effects of such a high strength of current, and the local circuit acts in aid of the weak retractor. If spring, *s*, of relay, R′, is adjusted for a current of strength, 3, a current of strength, 5, would overpower *s*; but as the current 5 actuates armature of R″ to close on front contact local circuit of battery, B, and magnet, *m*, *m*, acts in conjunction with *s*, and the retractile force upon the lever, *o*, is automatically increased and made to bear the same ratio to the current, 5, that the force of spring, *s*, alone bears to force of current, 3, it is obvious that according to the same plan the retractile force of *s* could be still further aided by calling in more local battery by the action of relay, R‴, when current of strength, 7, is sent. A local electro-magnet, *m′*, is applied in the same manner to aid the retractile force of *s′*. *m′* is only called into action when a current of strength, 7, is sent to line.

Local electro-magnets, *m* and *m′*, will act upon their respective armatures, when armatures, *o′* and *o″* of R″, and R‴, are upon their front contacts; but, should the front contacts be momentarily broken by reversals of the main-line current, *m* or *m′* would exert a variable retracting force. To avoid such difficulty springs 40 and 41 have been placed upon the ends of armature-levers, *o″* and *o‴*, leaving a slight range of movement of the armature, without breaking the local of *m* or *m*¹. Thus the front contact may be preserved even if armature-bars, *o′* and *o″*, are slightly vibrated upon reversals of currents.

On short wires this system has worked perfectly. It was tried by the Western Union between New York and Philadelphia, in January, 1881, with marked success, but the high potential of current used with the rude experimental apparatus at that time could not be trusted upon the defective cables across the Hudson River.—*The Operator*, New York.

PROCEEDINGS OF SOCIETIES.

THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

AN ordinary general meeting of this Society was held on Thursday, April 27th, LIEUT.-COL. WEBBER, R.E., President, in the chair. The minutes of the last ordinary meeting having been confirmed, and the list of new and proposed members read, a paper was delivered by Mr. A. STROH, on "Attraction and Repulsion due to Sonorous Vibration, and a Comparison of the Phenomena with those of Magnetism." The author stated that his paper dealt with phenomena closely resembling magnetism, though not electrical or magnetic actually. The hydrodynamic experiments of Bjerknes, shown at the Paris Electrical Exhibition, had suggested the idea to him of producing the effects he was about to describe, and, whilst being able to reproduce the results obtained by Bjerknes, he had succeeded in advancing a step or two further, and effecting results which could not well be obtained by the hydrodynamic method. The experiments were carried out chiefly by means of small membranous drums of about the size of a shilling, fixed at the ends of tubes, the air in which was kept in vibration by means of a reed at the further extremities of the tubes, this reed being either actuated by a bellows or by electrical action. It was shown that if two of these vibrating membranes were held near each other, that attraction resulted when the vibrations of the two were in unlike "phase" and repulsion when in similar "phase."

These experiments and others which resulted from them were of an extremely beautiful and interesting character, and we purpose to illustrate and describe them at length.

PHYSICAL SOCIETY.—APRIL 22nd.

Prof. CLIFTON, President, in the chair.

New Member—Dr. E. HOPKINSON.

THE PRESIDENT announced that copies of the Report of the Lightning Rod Committee could be obtained from Dr. Guthrie, Science Schools, South Kensington. Price, 5s. per copy.

A paper was then read by Mr. W. F. STANLEY on "The Evidence of a flowing Liquid moving by rolling contact upon the interior surface of a Pipe."

In his experimental work on Fluids published last year the author has endeavoured to show that liquids flowing in a tube move by rolling contact on or past the resistant surfaces of solids, and upon like principles that the moving parts of a flowing liquid move by rolling contact on the more quiescent parts of its own mass, so that in no case is there any element of sliding, gliding, or shearing motion such as is generally assumed. Further experiments tend to support this view in the case of liquids flowing through pipes. The difficulty in the experiments arose from the friction of the pipe impeding the free motion of the particles. The principle was investigated by allowing liquids of various kinds, such as solutions of mastic varnish, to flow through pipes; the liquids containing colouring matter or air particles to assist the eye. The author illustrated the effects by diagrams on the screen.

Dr. W. H. STONE, Mr. BLACKLEY, Dr. GUTHRIE, and the PRESIDENT offered some remarks on the paper.

Mr. S. W. WHIPPLE exhibited the magnetograph curves obtained at the Kew Observatory during the past week, showing the progress of the recent magnetic storms. After stating that two unusually large spots were now passing over the sun's disc, he remarked that although the magnets at Kew were somewhat disturbed on the 14th they were nearly stationary until the night of the 16th, when about 11·45 p.m. they became strongly affected, and from then till 8 p.m. on the 17th the magnetic storm raged. The horizontal component of the earth's magnetic force was at one time reduced more than 0·05 m.m. mgrs. below its average value, and the vertical component by about 0·07 of the same units. This happened about 6 a.m. on the 17th. A little after noon on the same day both forces became so increased that the light spot left the scale of the instrument for nearly two hours. A second period of magnetic disturbance commenced at about 3.40 a.m. of the 20th, and was violent up to 2 p.m., subsiding gradually until 7.45 a.m. of the 21st. During this period the magnetic force, though fluctuating largely, did not experience such great changes of intensity as were indicated by that of the 17th. Mr. Whipple then alluded to the work of Prof. W. G. Adams, and suggested that sun's spots only produced such effects when cutting certain lines of force, which he imagined might extend for a limited angular distance round the earth's radius vector.

Prof. ADAMS pointed out the desirability of increasing the number of self-recording magnetic observatories, especially in the southern hemisphere; and, after mentioning that the French were about to equip such an observatory at Cape Horn, expressed the wish that the Cape of Good Hope observatory might again be provided with magnetometers.

The Rev. S. J. PERRY remarked on the exceptional nature of the storm which he had seen recorded at Brussels, and stated that in Belgium the telegraph service had been disorganised by it. Attention was also called to the auroral displays in America, and Mr. LECKY, Dr. GUTHRIE, the PRESIDENT, and others spoke on the general phenomena of the storms.

It was then announced that the meetings of the Society in May would be held on the 6th and 20th, instead of on the 13th and 27th as previously announced; also that the Society would hold a conversazione at the Clarendon Laboratory, Oxford, on June 17th, by invitation of the President.

ROYAL SOCIETY OF EDINBURGH.

AT the tenth ordinary meeting of this Society, held on the 17th inst., amongst the several communications laid on the table was one by Professor BLYTH, "On the Action of the Microphone." In his communication the Professor describes a number of experiments which he had made to discover the cause of the sound in the microphone. In these experiments two pieces of carbon formed the microphone, which, in conjunction with an ordinary Bell telephone and a battery, completed the circuit. He goes on to show that it is essential to the proper action of the microphone that the two carbons be not pressed too tightly together; and, therefore, the description "loose contact" describes with sufficient clearness what is meant. He proceeds: "It is well known that if any sound is heard in the telephone at all, it must be due to a variation in the current strength passing through the circuit. Now, in what way do the sound waves falling upon a transmitter, falling upon the 'loose contact,' produce sound waves in the circuit? The electromotive force being constant, the variation of the current strength must arise from the variation of the resistance at the point of 'loose contact,' the other portion of the circuit remaining unaffected. In what way, then, do the sound waves produce this variation? By two effects: by their direct passage through the air, and by their striking against the whole of the instrument. These two effects, which I shall call the air effect and the tremor effect, I have in my experiments endeavoured to keep separate. It is easy to isolate the air effect from the tremor effect; all we have to do is to include the microphone along with a small clock in the receiver of an air-pump. When this is done the sound of the clock is heard, and is very slightly altered, if at all, but not in degree of loudness but quality of sound. After describing other arrangements for isolating the air and tremor effects, and observing the actions of the microphone when acted upon by the one or the other, he said the tremulous action, as originally explained, is that variation in the pressure on two pieces of carbon caused a variation in their resistance. Variation by pressure is not good, and has been repudiated by Prof. S. Thompson in the *Philosophical Magazine*; the conductivity in carbon by pressure being *nil*. The pressing together of two carbon points is not the same as the coming in contact of two ivory balls, for in the former you have a crumbling action which has no part in the latter. He had found that when an electric arc was passing, singing came out quite distinct, and confessed a difficulty in understanding that there can be any effect due to the variation under pressure, and believed that when the particles of carbon are passing from point to point the

sonorous waves affect them, and thereby the resistance of the arc and current. Great difficulty was experienced in getting a continuation of the arc for a length of time. An attempt to produce the arc by means of statical electricity instead of voltaic revealed the fact that the current from a Holtz machine was unable to work the microphone for the production of articulate speech, although it was sufficient for the hissing sound. The shaking of the loose joint made little or no difference. The Professor, in summing up, says his idea is that when the "loose contact" resting on a sounding board is acted on by the tremor effect, the "jump" produced separates the carbon points; the air effect comes in and gives quality to the sound—the two effects taking place simultaneously alter the resistance of the arc, and, of course, the resistance of the current.

CORRESPONDENCE.

TO CORRESPONDENTS.

No notice can be taken of anonymous communications. Whatever is intended for insertion must be authenticated by the name and address of the writer, not necessarily for publication, but as a guarantee of good faith.

Correspondence should arrive not later than Tuesday morning if it is desired to appear in the following number

THE EDISON ELECTRIC LIGHT.

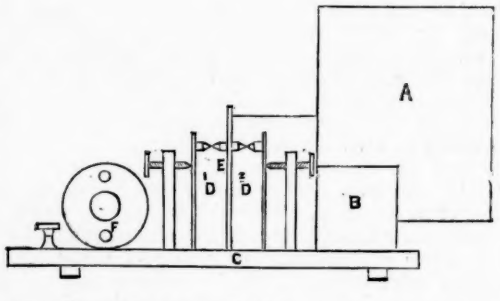
The Secretary of the Edison Electric Light Company, Limited, presents his compliments to the Editor of the ELECTRICAL REVIEW, and requests the insertion of the accompanying paragraph.

"The *City Press* was misinformed when it stated that any engine broke down or that there was anything beyond a momentary cessation of light. A distinguished party were inspecting the Edison Company's station at Holborn Viaduct for the manufacture and distribution of electricity, and in order to demonstrate the facility with which an accident to the dynamo could be remedied, the current was switched on to the spare machine. It is a question whether the light disappeared even for 10 seconds."

A MICROPHONE TRANSMITTER.

To the Editor of THE ELECTRICAL REVIEW.

SIR,—May I ask you to insert in your next week's issue the following description of a microphone transmitter for giving *undulatory* currents, such as are given by a Bell telephone when so used? A is the drum of an ordinary toy



telephone, supported by a suitably grooved piece of wood or ebonite, B, which latter is fastened firmly to a long flat piece of similar material, C, forming a stand for the whole succeeding arrangement. D^1 D^2 are two thin strips of brass, carrying ferrules, which hold two small rounded bits of carbon. E is a similar central strip, but slightly longer, to the top of which is soldered a steel wire firmly fastened at its other end to the centre of the parchment diaphragm of A. The brass strip E also carries, below the wire, a ferrule which holds a carbon pencil sharpened at both ends, which impinge on the carbon knobs of D^1 D^2. Behind D^1 D^2 are two brass pillars with screws for adjusting D^1 D^2, with respect to E. At the extreme end of C are three binding screws, only one of which is shown in figure; the central one being connected with E, and the outside ones with D^1 D^2. By suitable wires the central binding screw is also connected through the primary of small induction coil F (to be removed if wished) to the middle of a split battery, and the outside binding screws with the ends of the battery. An ordinary Bell telephone is used as receiver, and is connected with secondary of induction coil F. It is evident that at each oscillation of the parchment diaphragm the carbon pencil on E makes contact with those on D^1 D^2, at least theoretically so; of course practically the central carbon is constantly in contact with both the others.

This microphone works well with two Daniell cells, but rather better with four; of course number and size of cells depend on size of primary wire in the small induction coil, and if used without, a great number of cells must be used. I have had it in use for a year without fail, and have always found it articulate louder for a given distinctness than any others I have tried. If any of your readers think of trying it I shall be glad to afford them any further details, and shall also be glad to hear the result of their experience.

I remain, dear Sir,

Yours faithfully,

Chard, *April 27th.* J. WILLIAM GIFFORD.

ELECTRIC LIGHT PATENTS.

To the Editor of THE ELECTRICAL REVIEW.

SIR,—Your article upon "Electric Light and Power Companies and their Patents," in your issue of April 22nd, is in every way admirable and was much needed.

I would point out that at present only the two American companies have resorted to such intimidation by bounce.

The Edison Company's much displayed and very ambiguous advertisements are, in the opinion of many professional men, bounce, pure and unadulterated, and as such are utterly unworthy of the great inventor under cover of whose name they are used.

The Brush Company's recent and well-known threat against a rival and better arc lamp system is another instance of bounce, and should be contrasted with their letter to the *Times* of recent date, in which they say, "It seems to my directors a matter of very questionable taste for Mr. Edison, or those who are financially interested in his patents, to seize the opportunity of making a statement of the positive character of a judicial decision at a time when the Great Western Electric Light and Power Company's (Limited) prospectus is in the papers, and when it is notorious that the Edison interests are likewise endeavouring to raise capital in this market."

I would say to inventors, do not be discouraged or put down by such Yankee tricks, but for defence make a most careful search of all the existing patents, remembering that a prior publication will invalidate a later patent. Such a search is in itself most interesting, and will amply repay the trouble, and will serve to point the moral that "those living in glass houses should not throw stones."

It is a fact that whilst electric lighting has been known and perfected in England for now over thirty years, it is comparatively a new discovery in America.

I am, Sir,

Your obedient servant,

April 27th. FAIR PLAY.

AN IMPROVED MORSE KEY.

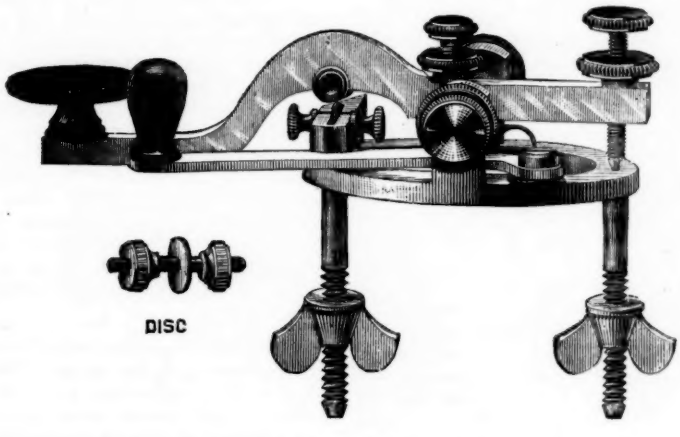
To the Editor of THE ELECTRICAL REVIEW.

SIR,—An advertisement in an English publication announces a method of obtaining a contact that will work without sticking on the $\frac{1}{3\,3}$ of an inch play. Is it possible that that amount of motion is considered extraordinary in your country? In the United States it is not unusual to find keys or relay points working on the $\frac{1}{6\,4}$ of an inch motion, or less, provided they have been recently filed clean; the size of the platina wire being, say, about $\frac{1}{1\,6}$ of an inch diameter. Realising that this play was too great to admit of rapid transmission with any degree of accuracy, and having long been convinced that the minimum surface of contact was the desideratum, I have found that by swinging two discs at right angles and impinging on their peripheries, this

minimum contact is reached theoretically in a geometrical point. By rounding the edge of the wheels used as electrodes—or, what is better, running a densely drawn platina wire in a groove on the periphery of a brass wheel—the surface at the impinging point is found practically to be about the size of a needle's point. By this means, as is best described in the diagram of the inclosed circular, I obtain a contact that can be screwed down to the $\frac{1}{1000}$ of an inch vertical motion without sticking, even if used with an intense dynamo battery. Inasmuch as $\frac{1}{32}$ play seems to be a surprising feat in England, no doubt many of your readers will be sceptical about the truth of this assertion. In that event I would beg that they send to me for particulars, or go and examine the instrument for themselves. Several of the American style, single and double current keys with the periphery contact disc electrodes, are now on exhibition at the Crystal Palace (Edison Department), and they were deemed worthy of a medal at Paris last October. I would be happy to have them thoroughly tested by every electrician who desires to do so. Patents have been granted in the United States, and application for same filed in England, France, and Germany.

GEORGE CUMMING.

219, East 18th Street, New York, U.S.A.



[The fig. here given represents an American key fitted with the Cumming periphery contact. The invention is very highly spoken of, and its range of application is obviously not limited to telegraph keys only. We doubt, however, whether it will find favour in England, as the evils which it cures very rarely exist here, chiefly, no doubt, in consequence of the comparative shortness of the circuits and the low battery power used to work them. A sticking key is almost unknown in this country.—ED. ELEC. REV.]

BURGLAR ALARMS.

To the Editor of THE ELECTRICAL REVIEW.

SIR,—Can you give me a sketch or an explanation for protecting a jeweller's shop (by an electrical arrangement) from burglars; I wish to connect the glass cases, doors, walls, and floor. A reply through your journal as to cost of apparatus for, say, a dozen connections and fitting the same will oblige.

CONSTANT READER.

May 1st, 1882.

[In our issue of February 11th, page 110, will be found the information which you seek. Any local electric bell fitter would give you an estimate as to cost, which would probably be between £3 and £4, including everything.—ED. ELEC. REV.]

THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.—The next meeting of the Society of Telegraph Engineers and of Electricians will be held at 25, Great George Street, on Thursday, May 11th, 1882, when the following papers will be read:—1. "Measuring Instruments used in Electric Lighting and Transmission of Power." 2. "The Technical Education of an Electrical Engineer." By Professors W. E. Ayrton and John Perry.

NOTES.

THE CADIZ AND CANARY ISLANDS CABLE.—The Spanish Government have received no tender for the proposed cable from Cadiz to the Canary Islands. This is the second time that no tender has been submitted in answer to the official inquiry for prices.

TELEGRAPHIC COMMUNICATION IN SPAIN.—From July 1st, 1882, all the railway companies in Spain will accept telegrams from the public. In addition to the existing telegraph stations, 800 new offices will thus be opened on the above date, and will, it is considered, give great impetus to telegraphic communication in Spain.

THE DIRECT SPANISH TELEGRAPH COMPANY'S CABLE.—This cable between Bilbao and Falmouth was interrupted on April 30th, and the India-rubber, Gutta-percha, and Telegraph Works Company, Limited, are intrusted with the repairs, having engaged the Great Northern Telegraph Company's steamer *H. C. Œrsted* to effect the operations, under the direction of Mr. A. Le Neve Foster, assisted by Mr. A. S. Page. The fault being in shallow water, it is expected that the cable will be promptly restored.

TELEGRAPH LINES IN CHINA.—The *Archiv für Post und Telegrafie* gives the following information about the construction and working of the Chinese land-line from Shanghae to Tien-tsin, which line is now open to international telegraphs.

The telegraph line between Shanghae and Tien-tsin is the first line opened in China to the international telegraph service. It required five months to establish this line, but, considering that during a third of that time the gangs of workmen were stopped through want of materials, it is an undertaking which may be considered as having been carried out with great activity.

The construction of the line began simultaneously at the two ends, each gang being composed of four agents of the Great Northern Telegraph Company and 120 Chinamen, who, first of all, had to be taught this kind of work, which was quite new to them. As a rule, the Great Imperial Canal was used to convey the land-line material to the working sites, but in cases of low water the distribution of the material had, on many occasions, to be made by means of carts or carriers. For instance, the cable, one mile long, intended for crossing the Yellow River had to be carried by soldiers a distance of four miles. Besides the two end stations of Shanghae and Tien-tsin, the line passes through the towns of Soochow, Chiankiang, Chiankiang-Poo, Chining, and Linching. Each of these stations is in charge of an agent of the Great Northern Telegraph Company, who superintends the service, under the nominal authority of a Chinese superintendent. The native working staff, consists of thirty persons, and is for the greater part composed of pupils from the Telegraph School, established in Tien-tsin at the end of 1880, and also of a few young Chinamen who have learned to telegraph somewhere else.

The Telegraph School in Tien-tsin at present has thirty pupils, the greater part of whom have resided for many years in the United States of America. The school is under the management of two agents of the Great Northern Telegraph Company.

All the preparatory work has already been finished, and the necessary materials distributed for another line, about eighty English miles long, between Chiankiang and Nanking. The construction of two more lines will shortly be undertaken, viz., from Soochow to Ning-Po, *via* Hangchow, and from Chiankiang-Poo to Tsin-Au-foo, the capital of the Province of Shantung.

UNDERGROUND TELEGRAPH CABLES IN FRANCE.—We read in *La Lumière Electrique*, of April 29th, the following: "Great progress is being made in the north of France with the laying of underground telegraph cables. The underground line is already established between Paris, Saint-Quentin, and Cambrai. To proceed safely with the repairs of these lines in case of interruption, 'marmites,' a kind of test boxes, are placed at intervals of five hundred metres when the line is straight, but closer together at all places where there are curves in it. These boxes serve at the same time as so many mark-points on the line. The placing of these boxes is so well arranged that, from a telegraph station which is in communication with the underground cables, it is very easy, if necessary, to find out to what box the workmen should proceed to repair a broken wire. The length of the core or cable which the workmen then pulls out will show him exactly where he should begin to dig in order to repair the line. These underground cables are not intended to replace the overhead telegraph wires; they are not even to be used for private telegrams. For the present the Government keeps them at their disposal. The network of underground telegraph lines which is now being laid from Paris to Lyon and to Marseilles will cost not less than 42 million francs. On nearly the whole of the lines from Paris to Lyon the work of pulling the cables through the pipes is now being carried out. This is done by means of a wire rope left in the pipes when they are laid in the trenches. Three cables, wound on drums, and having each three conductors, are thus pulled through the pipes. We were in hopes that the underground line between Paris and Lyons would be ready by the 1st of May, but unfortunately the work is delayed."

TELEGRAPH COMMUNICATION ALONG THE RHINE.—The German Government has decided to establish telegraphic communication along the Rhine, between Huningen and Strasburg, in order to organise an efficient service in case of any overflows of the Rhine. This new line will be constructed as soon as possible.

THE RED SEA CABLE.—The cable to be laid in the Red Sea will connect the port of Jiddah, in the province of Hedjaz, with the port of Sawakim, situated on the Egyptian coast. The cable has to be made and laid within five months from the date of signing the contract. The construction of the land-lines, which have been projected for some time, in the province of Hedjaz, will now begin as soon as possible. The first of these lines will go from Jiddah to Mecca, passing through Taif. This line will then be continued to Medina, and from there to the port of Yenbo. It is, further, the intention to resume the interrupted work of the land-line from Hodeida to Cunfidah, on the coast of the Red Sea, by extending this line from the latter point to Jiddah. In this way a complete network of land-lines will be obtained in the two provinces of Hedjaz and Yemen, to be worked in connection with the Egyptian land-lines, which go as far as Sawakim, by means of the cable to be laid from that port to Jiddah. Telegraphic communication between these two provinces and Constantinople will then be continuous by way of Cairo and El-Arich, or by way of Alexandria and the cables of the Eastern Telegraph Company. The length of the cable between Jiddah and Sawakim will be about two hundred nautical miles.

THE CABLE SHIP *Silvertown*.—The Silvertown Telegraph Company inform us that they have received a telegram from Mr. M. Hamilton Gray, engineer-in-charge of their s.s. *Silvertown*, announcing the safe arrival of that vessel at Lota (Chili) on the 24th ult. All well on board.

PROPOSED ELECTRIC LIGHT AT BILBAO.—The Bilbao port authorities contemplate the erection of two powerful electric lights—one near the dangerous bar, in order that vessels may enter and sail by night, and another affording means for the discharge and loading of steamers after nightfall. This would duplicate the already immense trade at Bilbao.

SWAN'S ELECTRIC LAMPS.—Hans Makart's colossal painting of "Diana's Hunting Party," which was illuminated in the Central Exchange Art Gallery, Newcastle-on-Tyne, by 20 Swan's incandescent lamps in multiple arc circuit, has been on view in the Albert Hall, Dundee, and illuminated by 30 Swan's lamps, supplied by the local electric light company. Also the large drapery establishment of Messrs. Coxon and Co., Newcastle-on-Tyne, has for several weeks been lighted by Swan's incandescent lamps, under the management of the Swan Electric Light Company. The direct current dynamo used is driven by a 12-horse Otto gas engine.

DYNAMO-ELECTRIC MACHINES.—We extract from *Nature*, of April 27th, the following note:—A new dynamo-electric machine, recently brought before the Belgian Academy by M. Plücker, has the peculiarity that a solenoid is substituted for the electromagnet as an organ for excitation of the induction currents. The horizontal coils of the solenoid, which is of special form, are traversed by the currents produced by the machine itself. The apparatus rotated within the solenoid is a wheel with coils arranged nearly like those of the Gramme ring. The whole system is inclosed in an iron armature meant to increase the inductive action. M. Plücker states that he replaced the solenoid with electromagnets, and the apparatus produced the same effect. He seems merely to claim the advantage of less weight and volume.

THE GULCHER ELECTRIC LIGHT.—We had an opportunity of inspecting this system of electric lighting on Tuesday last at the engineering works of Messrs. Ransome & Co., King's Road, Chelsea, where eight large arc lights are shown in operation in parallel circuit and driven from one machine. We shall hope to be able in a short time to give a full account of Herr Gülcher's present arrangements, and in the meantime we may say that the impression produced was a very favourable one, the steadiness and purity of colour of the lights being remarkably good.

THE GOVERNMENT ELECTRIC LIGHTING BILL.—At a recent meeting of the Leith Town Council it was agreed to petition against the Government Electric Lighting Bill, unless clauses were inserted giving the local authorities absolute control over the streets and the appliances that would be rendered necessary.

THE Electric Lighting Committee met for the first time on Wednesday, and appointed Mr. Stanhope as their chairman.

IN the House of Commons, on the 28th ult., Mr. Chamberlain moved:—"That the following Bills be referred to the select committee on the Electric Lighting Bill:—1. Anglo-American and Brush Electric Light Corporation. 2. Electric Light and Power Generator Company. 3. British Electric Light Company. 4. Dublin Electric Light and Power Company. 5. Siemens Brothers and Company (Electric Lighting). 6. Edison's Electric Lighting. 7. Aberdeen Lighting. 8. Dundee Lighting. That all petitions presented during the present session against any of the said Bills be referred to the committee; that the petitioners, as also the promoters of the said Bills, be at liberty to be heard by counsel, agents, and witnesses upon the Electric Lighting Bill, and that such of the petitioners as pray to be heard by themselves, their counsel, and agents, be heard upon their petitions if they think fit; and that counsel be heard in favour of the said Bills against the said petitioners only on those Bills on which their *locus standi* has been admitted in the usual way." The motion was agreed to.

ON Monday, May 1st, the Siemens Brothers and Company Electric Lighting Bill was read a second time.

NEW COMPANIES REGISTERED.

Brush Electric Light and Power Company of Australasia, Limited.—Capital £51,000 in 500 shares of £100 each and 200 founders' shares of £5 each. Objects: To acquire and work the patent rights for the Australasian Colonies granted in respect of the electric inventions of C. F. Brush and St. George Lane Fox. Signatories (with one share each): Sir Julius Vogel, 135, Cromwell Road; *Howard Spensley, Kensington Palace Mansions; Benjamin Isaac, 22, Great Winchester Street; *Philp Falk, 23, Kensington Palace Gardens; John Muirhead, C.E., 23, Regency Street, S.W.; *George Bennett, 5, Copthall Buildings; *F. S. Isaac, 22, Great Winchester Street. Directing qualification, 20 shares of £100 each. Mr. C. Wade is appointed a director. Registered 28th ult. by Trinders and Curtis Hayward, 14, St. Helen's Place.

Gulcher Electric Light and Power Company, Limited.—Capital £300,000 in £5 shares. Office: 121, Bishopsgate Street, E.C. Objects: To purchase the British letters patent, dated 10th May, 1881, No. 2,038, granted for "Improvements in electric lighting apparatus," and provisional protection for certain improvements in magneto-dynamo machines, the inventions of Robert Jacob Gülcher, of Bialabei Beilitz, Austria. The purchase consideration is £25,000 in cash and 15,000 fully paid shares. Signatories (with one share each): *John Blundell, 74, Elsham Street; *Major-General A. H. Bogler, Junior United Service Club; *F. Gilman, Crown Court, Old Broad Street; *W. C. Harvey, 27, Clement's Lane; F. C. Monkland, 19, Gresham Street; *J. Norton, 24, Old Bond Street; *J. A. Pledger, Chelmsford. Mr. Hugh Colville Macdonald is appointed a director. Directing qualification, 50 shares; remuneration, £1,500 per annum. Registered 1st inst. by De Jersey Micklem and Son, 19, Gresham Street.

South Eastern (Brush) Electric Light and Power Company, Limited.—Capital £100,000 in £5 shares. Objects: The carrying on of the ordinary business of an electric light and power company. Signatories (with one share each): Francis Fesser, 32, Cambridge Gardens; General M. K. Kennedy, R.E., 26, Leinster Square; T. Fry, 11, Manor Park, Lee; C. Wapshawe, Selhurst Road, South Norwood; R. Cunningham, Kingston Hill; George Offor, 24, Crutched Friars; E. F. Grainge, 4, Addington Street, York Road, S.E. Directing qualification, £250 (nominal) in shares. The signatories are to nominate the first directors; remuneration, £1,000 per annum. Registered 2nd inst. by Walter Webb and Co., 23, Queen Victoria Street, E.C.

* Signatories whose names are preceded by an asterisk are also directors.

The Faure Accumulator Experiments.—*L'Electricien*, in comparing the official note on the above subject, presented to the Academy of Sciences, with the report sent to our contemporaries by the *Société Force et Lumière*, Jan. 24th, 1882, a few days after the experiments, says:—

The latter contains the following passages:—

"The accumulators, to the number of 35, belonged to the laboratory type; they were round, with an inner vessel of stone, the external diameter being 25 centimetres, total height 35 centimetres, and total weight about 30 kilogrammes with the water." . . . "Finally, one of the most important results of the experiment was—that the 35 accumulators, weighing together about a ton, gave an average result of 110 kilogrammetres during 11 hours, or more than 16 effective horse-power hours." (Page 13.)

On the other hand the official note says:—

"The battery placed at our disposal consisted of 35 elements on the new model, with plates twisted into a spiral, each weighing 43 kg. 700, including the liquid."

By calculation, we obtain 1,530 kilogrammes as the total weight of the 35 accumulators, and not about a ton, as the report says. *First error.*

According to the official note, the battery during discharge gave an average result of 110 kilogrammetres during 11 hours, or 4,356,000 kilogrammetres, but the official note gives the electrical work as 3,809,000 kilogrammetres only. *Second error.*

Taking the figures of the *Société Force et Lumière*, the Faure battery would store up available work to the amount of 4,356 kilogrammetres per kilogramme; whereas, in regard to the same experiments, the official figures only give—

$$\frac{3809000}{1530} = 2{,}500 \text{ kilogrammetres.}$$

Third error.

Finally, on calculating the weight of accumulators necessary to produce a horse-power hour, we get 62 kilogrammes according to the *Société Force et Lumière*; 108 according to the figures of the official committee. We see therefore that we did right to wait for the official statement, and to place only slight confidence in the report to which we allude, and which has been accepted and inserted *in extenso* by a great number of our confrères.

Having added more than 60 per cent. to the figures of the committee, by means of a series of clever exaggerations, the *Société Force et Lumière* shows us once more how much confidence must be placed in its statements, and also its ingenuity in the interpretation of results obtained by official experiments.

In connection with this matter we extract the following from *L'Electricité*, which will doubtless interest those of our readers whose attention may be directed to the question of secondary batteries.

"An electrical periodical has just published in its last number an article dwelling upon some discrepancies between the Company's report, which we published in our number dated January 28th, 1882, and the official account read by M. Tresca, a few weeks later, at the sitting of the Academy of Sciences on Monday, March 6th.

"As the journal in question seems indirectly to reflect upon us, since it was in *L'Electricité* that the other scientific journals of France and England found the note in question, we addressed ourselves to M. Faure, who kindly gave us a copy of the following letter, which we think it our duty to place before our readers."

To M. Hospitalier, Secretary to the editorial staff of *L'Electricien*.

Sir,—In your number of April 1st, you call attention to the discrepancies existing between the official statement presented to the Academy by M. Tresca and a report which had been forwarded to you. These discrepancies had also struck me, and as I was preparing the notes of a conference on the subject of my researches, I intended incidentally to rectify the errors of which you speak. The work which I continually have on hand prevented me from following up this idea as soon as I could have wished, but you have rendered me a real service by raising the question. It only remains for me to give an account to you of some observations I have made upon the subject. In the first place I wish to inform you that I am not taking up the defence of the Society, which is nothing to me in this discussion; but as my name is intimately associated with the question, and as I can better than any one furnish you with the truth on this subject, which is of great interest to you, I willingly accept the responsibility of the report.

Accept firstly my personal affirmation that this report was written in all good faith from the figures furnished by our instruments and noted down by M. Cote, engineer to the Society, and from those which the members of the committee kindly forwarded us. But let us return to facts. The figures of the official statement themselves are the best justification.

It is a fact that the charging machine was supplied by me; it was the only one at that time available.

Allow me to dwell upon the facts relating to this machine, for it plays a great part in what I shall say further on. It was in the first place an ordinary Siemens machine, excited by the principal current, and giving 25 ampères when in favourable conditions of working.

I had modified it by causing the derivation inductors to be excited so that it could charge 27 accumulators, which correspond to the number necessary to feed Edison lamps of one burner. As it was not proposed in making the experiments to see what a Siemens machine thus modified could produce, and as it was required to take into consideration the case in which Maxim lamps would be employed in the experiments, there was no objection to utilising any machine whatever for the charge, as was actually done, provided that these conditions were taken into consideration in the calculation, which was not done in the official statement.

For instance, it is this sort of voltameter or resistance introduced as a last resource into the exciting circuit which caused the exciting current to be on an average only 2·80 ampères.

This resistance, which can be calculated from the figures of the official statement themselves, was equal to 13 ohms, and consumed 10 kilogrammetres, as is stated in the report. In a machine constructed for the purpose of charging 35 accumulators, this resistance would be usefully employed on the inductors, which would increase the total result nearly 10 per cent. Referring you to the tables of the official statement, you will see that $\tau + \tau^{11}$, which forms the result of the machine according to M. Tresca's figures, would be equal to 86 per cent. Without wishing to contradict M. Tresca, I will remark that this type of machine—viz., Siemens D_2, working with its

normal excitation, by means of the principal current, at a speed of 600 revolutions, giving 20 ampères—has never given me more than 75 per cent.

I conclude then from what I have just said that the total result was at least 50 per cent.; there is therefore no difficulty in believing that the result obtained from the batteries was more than 60 per cent. I will incidentally remark that the electricians, Sir W. Thomson and Messrs. Ayrton and Perry, have always obtained in their experiments results above 70 per cent. Perhaps you will say they had batteries of less resistance: it might have been so.

I come now to the weight of the battery. The standard couple which served as a basis for the establishment of this series was weighed by myself. I found it about 30 kilogrammes, more or less, according to the quantity of water which it contained. Also these are the dimensions and weights of the substances employed:—

1st. A plate of lead $\frac{1}{2}$ a millimetre in thickness, length 1·40, width 0·28; this plate is perforated with holes of 6 millimetres, sufficiently near together to take off $\frac{1}{3}$rd of the weight. Total weight, including the leaden connection, 2 kilos.

2nd. A plate of lead 2 millimetres thick, otherwise similar to the one above mentioned. Weight, 6 kilos., 500.

The minium of the batteries was applied in the ratio of 10 kilos. per square metre to about a quarter of the 35 batteries, and in the ratio of 8 kilos. to the rest. It was applied to each side of the above-mentioned plates, excepting on those parts facing the sides of the recipients. Consequently, there was on an average, taking 9 kilos. as a basis, and on each couple, 12·60 kilos.

The weight of the metallic substances was thus 21·20 kilos. By mistake I gave M. Tresca a higher weight. The total weight of the 35 elements, including the lead and the oxide of lead, can be estimated at 740 kilos. Besides, the coiled cylinder of the plates were, or should have been, according to the type, 0·20 in diameter and 0·28 in height, which leads us to conclude that 4 litres of water would be sufficient to charge the couple.

Does this mean that I wish to express doubts as to the reliability of the report of the committee? No. I will merely remark that stone jars, especially when bought somewhat in haste, are very variable things; some are round, others oval, some cylindrical, and some not. There were some which measured 0·36 in height; the large jars would hold 8 litres of water more than the little ones; and besides, the lead merchants have the bad habit of exaggerating the thicknesses. Finally these jars were enclosed in a packing of wood and straw perfectly useless, but which weighed quite 4 kilos.

As you see, Sir, it is all easily explained. Thus a weight of lead and minium equal to 740 kilos. would have given 3,809,000 kilos., still taking M. Tresca's figures as to the work of discharge, *i.e.*, 5·140 kilos. per kilo.

I will remark, in conclusion, that the Society's report in two different passages makes reservations as to the absolute value of the special result which it gives of the experiments of the Conservatoire. As to the more general conclusions which it suggested, it had a certain right to calculate the total result from a weight of battery represented by the lightest couple employed, since practically, between the lightest type couple and the couples which were accidentally heavier, there was only a difference of inert matter, such as weight of water and of the recipient.

This point being explained, I take the liberty, Sir, of addressing to you some supplementary explanations on the theory of an apparatus in which you seem to be particularly interested, and about which I think your readers will be very glad to have fresh information.

I have carefully studied the electro-chemical theory of my battery, and also by repeated analyses the composition of the active layers of the electrodes at different periods of charge and discharge. Taking into consideration the current which had passed between two experiments, I thought I might assert that the effect immediately observable was the transfer of a certain quantity of oxygen from one electrode to the other, and *vice versâ*, according to the proportion established in electro-chemistry; and that during the discharge, for example, the lead reduced became Pb_2O, whereas the oxidised lead, Pb_2O^4, became Pb_2O^3. But I noticed that this only took place in a slight proportion to the total mass of the layers, about 10 per cent. I attribute this to the resistance offered by a quasi-solid substance, such as the rust of lead and its oxides, to the transmission of the electrolytic wave; in fact, a considerable portion of the mass escapes the action of the current. However, I have reason to believe that by compositions indicated in my patents, and careful construction, I shall succeed in augmenting very considerably the capacity of charge of my batteries.

Nevertheless, as it is, the battery can render very considerable services in the different applications of electricity; for at the present price of lead, and considering that in extensive applications, such as the lighting of a town, the labour of constructing great accumulating tanks would be almost insignificant in proportion to a weight of one ton. It can be estimated that the cost would not exceed 600 francs the ton, storing up 16 horse-power hours. Thus there are already for my battery great applications, in which its weight will only be a very secondary consideration. The result obtained is really the most important thing; but as this depends solely on the resistance of the couples, which itself depends on the ability of the constructor, it can be concluded that means will be found of satisfying the requirements of economy.

And besides, as an impartial writer, you should have stated: (1) that five of the couples, by the very fact of conducting the experiment, were only half discharged; (2) that the experiments having lasted six days, it is only just to consider the 10 per cent. loss of current due to this cause as a diminution of the practical result, and that altogether it might in all probability easily have amounted to 75 per cent. Lastly, allow me to add that my battery is at the present day the only industrial secondary battery; that it offers, as has been stated long before, forty times more storage capacity than any Planté battery whatever formed by the machine; and that, while admitting the figures of the committee, your readers can see the complete justification of my hopes, where lately they read (I say lately): "The Faure battery can be summed up in a few words: 'Much noise for almost nothing.'" As for electricity being brought into houses, "Much noise for less than nothing."—Accept, &c.,

C. A. FAURE,

April 8th, 1882. *L'Electricite.*

NEW PATENTS—1882.

1994. "Mechanical telegraphs for use on board ship, which improvements are applicable also to various other purposes." W. CHADBURN. Dated April 27.

1999. "Improved means of accumulating and storing electric currents, and in economically utilising the energy so stored for lighting purposes." J. B. ROGERS. Dated April 27.

2020. "Apparatus or means for obtaining electric light." J. C. ASTEN. Dated April 28.

2030. "Electric switches or circuit changers." Hon. R. BROUGHAM. Dated April 28.

2037. "Manufacture of electric incandescent lights in the vacuum." A. L. JOUSSELIN. Dated April 29.

2044. "Dynamo-electrical machines." Hon. R. BROUGHAM. Dated April 29.

2052. "Improvements in electrical generators and engines, and in apparatus or means for regulating generators of electricity." T. J. HANDFORD. (Communicated by T. A. Edison.) Dated May 1.

2065. "Improvements in microphonic conductors or contacts, and in the preparation of materials for such conductors or contacts." J. H. JOHNSON. (Communicated by A. D'Arsomal.) Dated May 2.

2068. "A new or improved secondary battery." C. H. CATHCART and C. B. G. COLE. Dated May 2.

2072. "Electric lights." T. J. HANDFORD. (Communicated by T. A. Edison.) Dated May 2.

2092. "Electric light apparatus." C. LEVER. Dated May 3.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1881.

4029. "Telephone transmitter." SYDNEY PITT. (A communication from abroad by Henri Machalski, of Austria.) Dated September 19. 6d. Relates to a transmitter with pulverised graphite.

4058. "Electrical cables." H. H. LAKE. (A communication from abroad by John Benjamin Henck, jun., of America.) Dated September 20. 6d. Relates to a cable formed of a series of overlapping conductors, by which the inventor anticipates he will overcome inductive retardation in submarine cables. The operation of the arrangement is as follows, that is to say:—Supposing a positive charge is communicated to the first conductor a negative charge will be immediately induced upon the overlapping portion of the adjacent or second conductor, and a positive charge will be repelled to the farther extremity or part of the said conductor, where it will in its turn induce a negative charge upon the overlapping portion of the next or third conductor, at the same time repelling a positive charge to the farther portion of the said conductor, and this action will continue to the end of the cable, where the charge may be employed to actuate any suitable receiving instrument.

3976. "Electric arc-lamps." PETER JENSEN. (A communication from abroad by Alexis Jean-Baptiste Cance, of Paris.) Dated September 14. 6d. Refers to an electric arc lamp having the light always kept in the same position and with automatic regulation, possessing important advantages, all as hereinafter described. Fig. 1 is a longitudinal section of a lamp constructed according to the invention. Fig. 2 is a view in section of that part showing the escapement. Fig. 3 is a view in plan of the escapement. The mode of operation of the lamp is as follows:—Before lighting the carbons are in contact; the current passing along by the wire to a terminal, *u*, on the upper base plate, *g*, distributes itself into the mass and passes to the lower carbon holder and to the upper carbon holder, ascends by the two corresponding vertical rods of same, insulated from the mass and communicating with each other by the lower cross bar; the rods of the lower holder slide easily through brass bushes, *v*, in the lower base plate, *k*, which bushes are connected by a conducting wire, *w*, which is also connected to one end of the coil of the bobbin; the other end of the coil is connected to the other terminal, *x*, on the upper base plate, *g*. As the bobbin becomes thus magnetised the core is drawn up quickly, and regulates the arc distance as follows: The lower cross bar, *r*, of the core carries an arm, *y*, to which is connected a rod, *z*, of adjustable length, which is connected also to one arm, a^1, of a bell crank lever mounted on the bobbin support, *l*, and the other arm, *b*, of which is bent, and engages with a tappet, e^1, on a swinging frame or bar, d^1, mounted loosely on the lower or step prolongation, *p*, of the screw, *j*. In the middle of this bar there is a tooth wheel, e^1, having a bush entering the bar loosely and fitting on a key or keyway on the screw prolongation. This wheel gears with a pinion, f^1, mounted in centres

on the bar. The spindle, g, of the pinion carries the escapement wheel, which advances against a stop spring, h, or recedes therefrom according as the carbons approach to or recede from each other. This wheel has by preference such a form, as shown, as to act as a brake as well as a stop; two consecutive escapement wheel notches are separated by a stop appliance, on which the stop spring rests and which suffices to arrest the wheel when the magnetic variation due to the approach is not large enough to bring the notch in front of the spring, and thus facilitates a subsequent approach. In the moment of lighting, the core is drawn up smartly, bringing up with it the connecting rod, z, and actuating the bell crank lever, a^1, b^1, the curved arm, b^1, of which

FIG. 1

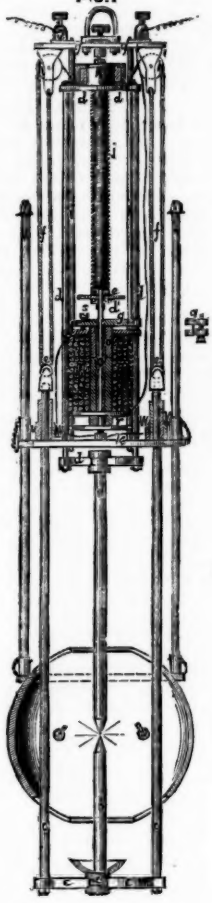


FIG. 2

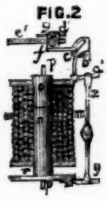


FIG. 3

pushes back the swinging bar, d^1, so that the escapement wheel engages with the stop spring, h^1, which enters one of the wheel notches, stopping the wheel and the tooth pinion, f^1, in one therewith from turning; this pinion, which always gears with its tooth wheel, e^1, causes the swinging bar, d^1, to turn a little in the opposite to its normal direction of movement; being fast with the vertical screw, j, this latter is turned, whereby its nut, d, h, is caused to rise a little, raising thereby the upper carbon while the lower carbon descends correspondingly. The arc being thus established the intensity of the magnetism in the bobbin will diminish as the carbons are consumed, and the core will descend; the escapement wheel goes away from the stop spring and finally escapes from it; the carbons will thus approach or recede according as they are consumed.

4107. "Dynamo-electric machine." F. E. FAHRIG. Dated September 23. 6d. Relates to an improved dynamo-electric machine, and the improvement consists in the form and construction of the armature, which is so made that the coils may be readily removed and replaced by others when necessary, or any one or more of them may be omitted entirely according to the quantity or the strength of the current required. In the dynamo-electric machine according to the invention the armature revolves between and in close proximity to the opposite poles of two sets of field electro-magnets, each set four or more in number placed parallel, those of the one set being symmetrically opposite to and in line with those of the other set. Their coils may or may not be connected together in series, and their cores are permanent steel magnets, so that no exciting machine is required. The armature consists of a number of straight coils with soft iron cores parallel with the axis of rotation of the armature, and arranged in the form of an annulus or ring; they are received in holes of corresponding size in the armature frame, and can be readily slipped in and out when it is required to vary their number or to replace them by others. The armature is mounted on a horizontal shaft passing between the field magnets, and mounted in bearings in a suitable frame, to which the cores of the field magnets are also fixed. The armature coils are separately connected to insulated segments of a commutator on the armature shaft, or they might be joined together in series if desired, the current being taken from the commutator by brushes in the ordinary way and partly sent through the coils of the field magnets, and partly utilised for outside work.

4128. "Distributing and regulating the transmission of electrical power." JOHN IMRAY. (A communication from abroad by Marcel Deprez and Jules Carpentier, of Paris.) Dated September 24. 6d. Relates to means of distributing and regulating the transmission of electrical power from the source where it is produced to a number of places where it may be employed. When a number of electric lights or machines are worked from one main circuit the use or disuse of one or more affects all the others. In order to provide against this, instead of connecting each of the lights or machines directly to the circuit, it is according to this invention connected to one of two batteries which has been charged from the main circuit, the other of the two in the meantime receiving its charge from the circuit so as to be ready for use when the former is more or less exhausted. In connection with the two batteries a commutator is provided, arranged to connect the circuit with each of the two batteries alternately, and the other of the two batteries to the light or machine that is to be worked. In order to diminish the variations to which a dynamo-electric machine is subject when the resistance of the circuit to which it is connected varies, the machine, instead of having its electro-magnets excited entirely from the circuit itself, is according to this invention arranged so as to have them partly excited from a source of electricity, which may be of a constant character, or which may be varied so as to counteract more or less the variations in the circuit.

4165. "Telephone-exchange apparatus, &c." ERNEST DE PASS. (A communication from abroad by Frank Shaw and William A. Childs, of America.) Dated September 27. 4d. Relates to improvements in telephone switch boards or tables, and other necessary apparatus for receiving orders for connections and disconnections from subscribers, and for giving and receiving orders for trunk-line connections and disconnections, and also for making such connections and disconnections, the former being made between subscribers' wires of one group or central office, and the latter between the subscribers' wires of any two groups or central offices, through trunk lines for subscribers' use between such central offices. The objects of this invention are to economise space and expense by reducing the size of the switch board, to save in the number and expense of operators, to save confusion, delay, repetition, and errors, and secure quietness, promptness, and accuracy, and at the same time to put the whole switch board under the control of such operators, one or more. (*Provisional only.*)

4174. "Electric lamps, &c." E. G. BREWER. (A communication from abroad by Thomas Alva Edison.) Dated September 27. 8d. The object of a portion of this invention is to furnish a simpler and cheaper method of providing the neck of incandescent electric lamps with the collar necessary for attaching the lamp to the supporting socket, and making the proper connections therein with the wire conductors, and also to produce a neater and better collar, including a method of connecting the wires of the lamp with the metal rings of the collar, so as to hide the wire ends from sight. Another part of this invention relates to lamps in which the glass wire support is held in a tapering, soft rubber stopper, forced in the neck of the globe; the object being to produce a simple lamp of this construction, in which the wire support cannot be forced by atmospheric pressure through the stopper into the globe, and the rubber stopper will be removed far enough from the light, so that it will not be affected by heat conducted therefrom by the glass globe, and no mercury seal will be required to produce an air-tight joint. A lamp of this construction is adapted to be taken apart when the carbon is destroyed, and all the parts except the carbon filament again utilised.

4202. "Incandescent electric lamps." J. W. SWAN. Dated September 29. 4d. Relates to incandescent electric lamps, and has for its object rendering more perfect the connection between the incandescent carbon filament and the metallic support which conveys the electric current to and from the same, and also obtaining greater uniformity in the carbonaceous filaments themselves; and farther, providing means whereby on the occurrence of rupture of a carbon filament in a lamp, another filament is automatically brought into circuit. In carrying out the invention, the inventor places the ends of the carbon filaments in sockets of platinum or other suitable metal, and deposits over the junction of the metal and carbon a coating of carbon by means of carbonaceous vapour, the filament being intensely heated locally at the points where the deposit is intended to take place, by the passage of a current of electricity through the filament and conductor. In order to effect the local heating above referred to, those parts of the filament which are to be kept cool, and on which the said deposit is not intended to be produced, are electrotyped. In order to produce uniformity in the light-giving power of incandescent electric lamps, the carbons of which have been strengthened or thickened by heating the carbon in a vapour of hydro-carbon or other carbon compound, there is arranged in a position contiguous to the filament under treatment, but not necessarily in the vessel in which the treatment takes place, a thermo-electric contact breaker, which acts in such a manner as to interrupt the passage of the electric current through the filament under treatment, when a standard temperature corresponding to a certain light-giving power has been attained. In order to effect the automatic lighting of a second carbon on the occurrence of the rupture of the one primarily in action, the main wire is divided into two branches, and one branch carried to one end of one carbon, hereinafter designated carbon No. 1, and the other branch to one end of the other carbon, hereinafter designated carbon No. 2, and the other ends of the two carbons are connected together in one common conducting wire. In one of the said branches there is interposed a solenoid or electro-magnetic coil attached to the lamp stem or contiguous to it, and in the other branch is interposed a mercurial or other contact-breaking device, so arranged that while

the current is passing through the electro-magnetic coil and carbon No. 1, the attractive force of the said solenoid or electro-magnet shall so operate as to cause a break in that branch of the conductor in which the carbon No. 2 is placed; and, therefore, prevent the current passing through it so long as the current is passing through carbon No. 1, but shall, on the rupture of carbon No. 1, allow of the completing of the circuit in the branch in which the carbon No. 2 is situate, so as to bring that carbon into operation.

4255. "Secondary galvanic batteries." ALEXANDER WATT. Dated October 1. 4d. One form of the secondary battery, according to this invention, consists of two or more plates of sheet lead coated with a mixture of manganese dioxide, calcium hydrate, and sodium chloride or calcium chloride, or preferably the mixture of manganous hydrate, calcium hydrate, and calcium chloride, known in the alkali trade as "Weldon mud," mixed with coarsely powdered carbon or coke. The plates coated on each side with the above composition, either as a magma or compressed and granulated, are placed in a leaden or other suitable tray containing solution of calcium chloride and piled one upon another, each plate being separated by a layer of felt or woollen cloth. The alternate plates are connected by strips of lead which have been left exposed for that purpose. The second form consists of alternate layers of carbon or lead plates, or a combination of the two, a mixture of manganese dioxide (needle manganese) and carbon or coke both reduced to a coarse powder, and felt or woollen cloth piled up in a tray, as in No. 1, the whole being saturated with solution of ammonium chloride (sal ammoniac), or sodium chloride (common salt), or diluted sulphuric acid. The alternate carbon or lead plates are connected as in No. 1. A more convenient form of cell consists of an ordinary battery jar divided down the centre by a diaphragm of porous clay, felt, cloth, or parchment. A plate is inserted in the middle of each division, which is then filled up with the mixture of manganese dioxide and coke, and filled with solution of sal ammoniac, common salt, or sulphuric acid, as above. The charged porous pots (either fresh or exhausted) of the well known Leclanché cell may even be used without further preparation than immersing a pair of them in one of the above solutions. Another modification of the battery consists of a porous pot containing a plate of carbon and charged with a mixture of manganese dioxide (needle manganese) and carbon or coke in a state of coarse powder, and placed in a leaden vessel containing diluted sulphuric acid, the space between the pot and the leaden vessel being filled with a mixture of manganese dioxide and carbon or coke, as above. The plate of carbon forms the one pole and the leaden vessel the other pole of the cell. Agglomerate plates, such as used in the new form of Leclanché cell, may be substituted for the above mixture. They may be attached to the carbon or lead plates by india-rubber bands, or they may be wound with lead wire and insulated in any of the above ways.

4271. "Electro-magnetic apparatus." W. R. LAKE. (A communication from abroad by Alexis Dobrochotoff Maikoff and Nicolas de Kabath, both of Paris.) Dated October 1. 6d. Relates to improvements in electro-magnets, and is designed to provide such magnets so constructed and arranged that the core surrounded by the wire coil acts, not as heretofore, upon an exterior armature, but upon an armature placed within the coil. This action is characterised by the fact that it is produced not by the attraction exerted by the current upon the armature, as in the solenoids hitherto employed, but by the repulsion caused by similar polarity being imparted both to the coil and to the armature, as will hereinafter appear. This manner of operating is obviously the inverse of that of ordinary

FIG 1

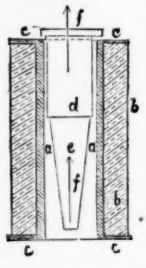


FIG 2

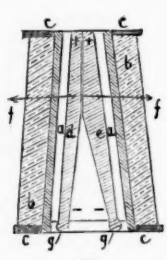


FIG 3

FIG 4

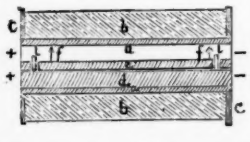
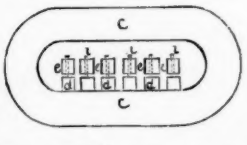


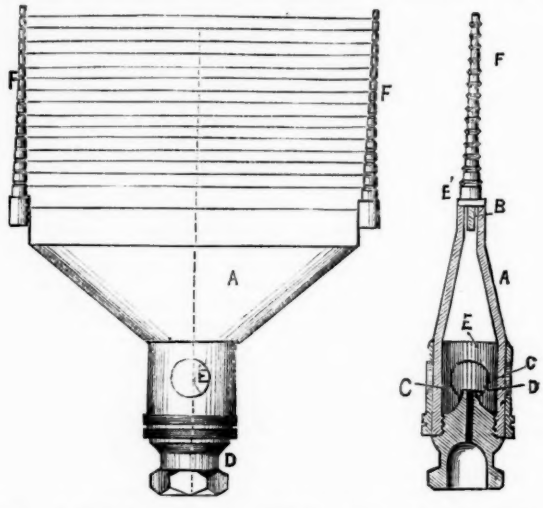
FIG 5



electro-magnets. Fig. 1 represents in vertical section an electro-magnet in which the movement of the armature takes place in an upward direction parallel to the axis of the coil. Fig. 2 shows in vertical section an electro-magnet in which the movement of the armature takes place perpendicularly or at right angles to the axis. Fig. 3 shows a top or end view of the armature illustrated in fig. 2. Fig. 4 represents in section, and fig. 5 in plan, an electro-magnet in which the movement of the armatures also takes place perpendicularly to the axis of the coil. In all cases the coil is formed with a tubular core, *a*, upon which the wire, *b*, is wound between two flanges, *c*, of iron, copper, wood, or other suitable material. In fig. 1 the core, *a*, is of soft iron, and the armature consists of a cylinder, *d*, having a tapering end, *e*. In whichever direction the current passes it will impart to the core, *a*, and to the armature, *d*, *e*, polarity of the same name, and the poles of like name facing each other will cause the armature to move outward in the direction of the arrows, *f*. In the arrangement shown in fig. 2 the coil has the form of a truncated cone, and its core is of copper, wood, or other non-magnetic substance. The armature consists of two pieces, *d* and *e*, capable of turning upon pivots, *g*. When the current flows through the wire of the coil the pieces, *d* and *e*, become polarised, and their poles of like name being opposite, the said pieces move away from each other, turning upon the points, *g*, as indicated by the arrows. In the modification illustrated in figs. 4 and 5 the coil contains a series of armatures, *d*, *e*, and to this end is made of an oblong shape. The action is the same as that above described, excepting that the armatures, *e*, being suitably guided by the pins, *i*, attached to the fixed pieces, *d*, move away from the said pieces, *d*, but in such a direction that they remain parallel thereto, as indicated by the arrows, *f*.

4310. "Secondary batteries." A. P. LAURIE. Dated October 4. 4d. According to this invention two copper plates are employed, or one plate of zinc or other suitable metal (hereinafter designated plate No. 1), and one copper plate (hereinafter designated plate No. 2), immersed in a solution of chloride of zinc, or the chloride of any other metal found suitable, such, for example, as chloride of aluminum. Plate No. 2 may with advantage be coated with copper in a fine state of division, and then wrapped round with linen, parchment, paper, or any other suitable material. When this battery is charged by means of an electric current zinc is deposited on plate No. 1, and chlorine is set free at plate No. 2. The chlorine immediately attacks the copper to form cuprous chloride. If this cell is now used to supply a current, the chlorine of the chloride of zinc attacks the deposited zinc and sets free zinc on plate No. 2. The zinc set free on plate No. 2 combines with the chlorine of the cuprous chloride to form chloride of zinc, leaving metallic copper.

5116. "Incandescent burners." H. J. HADDAN. (A communication from abroad by Walter Marsh Jackson, of Providence, United States.) Dated Nov. 23. 6d. Relates to an improvement in devices or system of devices for producing illumination by the incandescence of a suitable substance or substances heated to a proper temperature by means of burning gases or vapours, and it is specially designed to utilize for illuminating purposes the non-luminous gases, such as hydrogen, carbonic oxide, or a mixture of such gases, the latter being known technically as water gas, which either possess no carbon whatever, or do not contain it in such condition as to be rendered luminous when burning. Fig. 1 represents a side elevation of the improved apparatus or device. Fig. 2 represents a transverse vertical sectional view of the device. The letter A indicates an angular hollow shell which is provided with a narrow slot or opening, B, at its top, and at its bottom with a tubular extension, C, screw-threaded internally for the reception of an externally screw-threaded jet tube, D, which may be secured on a suitable pipe through which gas or vapour from a generator or reservoir may be



admitted to the hollow shell. The tubular extension, C, at diametrically opposite sides, is provided with openings, E, for the admission of air, which will be carried in by the draft caused by the current of gas passing upward through the jet tube, D. The said extension on its outside is provided with a loose perforated sleeve, the perforations corresponding with the apertures in the extension, so that by turning the sleeve the quantity of air admitted to the device may be regulated with accuracy. At each side at the top of the device the slot, B, is contracted, forming a seat for the rectangular cross bar or tie, E', to the ends of which are secured the vertical standards, F, which support the material to be rendered incandescent. This cross bar serves the double purpose of supporting the standards, F, and of dividing the opening or slot, B, so as to permit the gas or vapour to issue at each side. The standards taper upwardly, and are grooved at intervals for the reception of the substance to be rendered incandescent. The wire is wrapped successively in the grooves in the standards, one turn being given at each groove, in order to prevent the wire from loosening at its supports, and sagging or dropping under the influence of the intense heat necessary to render it incandescent.

CITY NOTES.

OLD BROAD STREET.

THE ELECTRIC LIGHT AND POWER GENERATOR COMPANY, LIMITED.

AN extraordinary general meeting of the above was held at the company's offices, 47, Cannon Street, on Wednesday, May 3rd, 1882, for the purpose of considering, and, if thought fit, passing the following resolutions:—"1. That the capital of the company be increased to the sum of £172,500 by the creation of 22,500 new shares of £1 each." These shares are required to be issued to Marcellus Hartley, of New York, in the United States of America, or his nominees, under the agreements with him for the purchase by the company of the Maxim, Nichols, and Weston patents. "2. That the bill as deposited by the company and introduced into the House of Commons be approved; and that the board be authorised to proceed with the same, subject to such additions, alterations, or variations as the board or either House of Parliament may think fit to make therein.

As the annual general meeting will be held very shortly, no other business was to be taken at this meeting.

We are unable to give any account of what took place at the above meeting as our reporter was refused admission, being assured that it was purely formal, only held to confirm the issue of shares determined upon twelve months since, and would not last five minutes. Seeing that this company has, comparatively, done scarcely any business, that changes of leading officials have taken and are taking place, that in addition to the £100,000 (beside £50,000 worth of shares to the vendors) commenced with, another £22,500 is now necessary for the payment of the above patents, and also seeing that a Press reporter was refused admission to the "general meeting," it seems to us high time that the shareholders should look to their property. We have heard many curious statements with regard to this company but have refused to give credence or publication to them without first having ascertained the accuracy thereof. Our confidence in the position and management of this company, we need hardly say, has not been by any means strengthened since the exclusion of our representative from the meeting.

THE INDO-EUROPEAN TELEGRAPH COMPANY (LIMITED).

THE annual meeting of this company took place on Saturday last, at the Cannon-street Hotel, the chairman of the company, Colonel Holland, in the chair. The managing director, Mr. W. Andrews, having read the notice convening the meeting, the Chairman said: Gentlemen—I have now, in accordance with our articles of association, to submit the list of registered members, and propose that the common seal of the company be affixed thereto. With your permission I now affix it.

I have now to submit the report and accounts for the year 1881. You will, I presume, gentlemen, take it as read, as usual. (Agreed.) I shall have to advert to various portions of it in the course of my remarks, which will, I trust, be very brief. Fortunately for us and for you, we are able to produce a satisfactory statement of accounts for the past year. Last year was by no means a bad one. We declared then, practically, an 8 per cent. dividend, and carried £7,300 to the reserve. This year, although we have had various difficulties to contend with which we had not in the preceding year, we are able to recommend the same dividend, and carry a somewhat larger sum to the reserve, viz., £8,000, thus what with the accretion of interest and so forth, increasing our reserve from £27,513, at which it stood last year, to £35,513 for the present year. With reference to the accounts generally, there is very little that needs to be entered into, unless any gentleman requires any special information, which I shall be happy to give; but in regard to the main point, expenditure, wages, which are slightly increased, is more than balanced by the increase of receipts. Further, I may add what I trust you will consider satisfactory—that we have not, so far as we know, one single bad debt. Just before this meeting the directors assembled to look over the accounts up to the latest hour, and they found only two debts, one from the Secretary of State for India, which I have no doubt you will regard as safe, and another of £2 3s. 6d. from a highly respectable party. So I think we are tolerably safe in that respect. With regard to the company's claims against the Russian Government, for damage done to our company during the war with Turkey, that remains very much in the same state in which it has been for some years now. We have ascertained that our receiving any portion or the whole of that claim depends on the outcome of claims by Russia upon Turkey. A great deal of diplomatic action is being carried on in respect to these claims. Should Russia be able to secure from Turkey the demands she has made, we may, I hope, come in for our portion. At any rate, the subject will not fail to receive our best attention. We have, among other matters of interest to you, to announce here that the Messrs. Siemens have given notice to terminate, on the 31st July next, the existing contract between them and the company for the maintenance of the company's line. This was a matter provided for in the articles of association—that after 12½ years if either party desired it they would be at liberty to determine the contract for maintenance. Messrs. Siemens have given that notice, at the same time intimating that they were perfectly willing to undertake the maintenance for the future on somewhat altered conditions. We have had a considerable quantity of correspondence on the subject, and, as is very often the case in matters of this kind, we differed in opinion as to what they should ask and what we should give. The fact is that in the result we felt ourselves very much in the position that the celebrated Mr. Canning felt when discussing the commercial relations with the Dutch Government. You may recollect the cipher despatch which he wrote to the Minister at the Hague—

> "In commercial transactions the fault of the Dutch
> Is giving too little and asking too much."

That was the opinion we came to. I have no doubt that Messrs. Siemens, on their side, felt very much the truth of the same adage. At any rate, we could not, in justice, as we conceived, to your interests, come to an arrangement with them; and the result is that we take the maintenance over into our own hands, and I say that the directors feel, one and all, no doubt whatever in their own minds that that will be satisfactory in the result to the pecuniary interests of the shareholders (hear, hear). At the same time that I make this statement I wish to say that we trust that every kind of amicable feeling may continue to exist between us and these eminent scientific gentlemen, the Messrs. Siemens, whose name is known throughout the whole civilised world for their science and enterprise (hear, hear). Well, gentlemen, we have among other matters adverted here to the interruption of our cables during the past year, and we state that for a considerable time the whole business of the country was carried on upon one of the two wires of the Indo-European line, irrespective of the other which was interrupted, and of the two wires of the Eastern Company, showing that the facilities for communication with the East are very much greater than the necessities of the case demand. Four wires are devoted expressly and entirely to Indian and Trans-Indian correspondence, and all these wires connected on the one side with several distinct routes on the western continent, and on the other side with India, China, and Australia; and, as I said before, the whole of the business has been satisfactorily carried on on the one wire. So satisfactory were our communications that the time for conveying a message from London to Calcutta was under one hour and a half, and I think, gentlemen, you will allow that merchants will be, as no doubt they were, perfectly satisfied with that fact, and I think the working arrangements speak somewhat for the management of this company, especially for the able executive control of my friend Mr. Andrews, to whom the greatest part of the credit is due (hear, hear). The cause of the existence of all these numerous wires is not very far to seek. There has been and still is a very keen and active rivalry between us and our friends of the Eastern, and between both of us and the Great Northern, at least so far as China and certain of the Trans-Indian countries are concerned. We do all of us our best to reach the British merchant, and when we have got him we do our best to keep him, and we have learned by experience the best way to keep him is to give all the facilities in our power, being satisfied with such moderate profit as will recompense you for the risk you have in holding our stock. I may mention that since the word-message was introduced, the messages have become shorter and shorter, most probably in consequence of the improvements made from day to day almost in codifying their words, so that a few words express a great many ideas. Although this takes away from our profits in one direction, yet the merchants finding the great facility with which they can express their desires in three or four words use them more frequently than they did the longer messages, so it is as broad as it is long, or rather it is broader than it is long; for although we find that though the increase on our profits is not very great, owing to the shortening of the messages, and the much larger amount of unpaid work which has to be done under the Convention, still the profit is increasing steadily, and we feel very little doubt that, by the increased facilities given to the mercantile community, our business will become a steadily increasing and profitable one.

We advert also in the report to a matter which has given us a great deal of trouble during the past year—namely, the interruption owing to the fracture of the cable between this country and Germany. Telegraphic cables are frequently breaking in many parts of the world; but in our lines, of no great length, across the North Sea there have been several vexatious disturbances, owing to fishing boats anchoring near the cable and carelessly damaging it, and interfering with the persons sent to repair it. This we find it impossible to rectify without application to Government. Government are always slow to move; but they have at last taken up the matter, and we are in communication with various continental Governments as to measures whereby injuries of this kind may be put a stop to. We owe a debt of gratitude to the Press, especially to the *Times*, but I may say the Press generally, for the active way in which they took up this case, and that of the merchants of England—because, after all, our cause of existence is the welfare of the mercantile community; and a very great debt of gratitude is also due to the well-known chairman of the Eastern Company, Mr. Pender, whose energetic support in the matter had a great effect in stimulating the Government to action. Let us hope that this cause of annoyance and interference with our profits, although it may not be thoroughly remedied, will be very considerably modified in the future.

There is nothing else that occurs to me to mention in the report, except to reiterate our regret at the loss of our valued colleague Mr. Barlow, who, on account of numerous and increasing professional engagements, felt it his duty to resign his seat. He, in a very kindly letter to his brother directors, offered his valuable technical aid on any occasion that we may desire to apply to him. We have done our best to fill the vacancy by appointing to the board Mr. Earle, who sits on my left hand, a gentleman well-known to the telegraphic world (hear, hear). We have also appointed our friend Mr. Weaver as official director, an appointment which Mr. Barlow held (hear, hear). There is no man in England, I believe, better known or more appreciated as a practical telegraphist than Mr. Weaver. I am quite sure I need not wait for any expression of opinion—for you have already expressed it—that you will be satisfied

with our choice. I beg to move the following resolution—that the report and statement of accounts be read and adopted.

Mr. Tritton seconded the motion, which was carried *nem. con.*

The Chairman: I have now to move that a dividend be and is hereby declared for the half-year ended 31st Dec., 1881, of 17s. 6d. per share, making with the interim dividend already declared 6 per cent. for the year, and a bonus of 10s. per share, both free of income-tax.

M. Tremenheere seconded the resolution, which was also passed unanimously.

The chairman having vacated the chair, it was taken by Mr. Tritton, who said that, in accordance with the articles of association, Colonel Holland and Mr. H. H. Meier retired by rotation, and it was now his duty to move their re-election.

Mr. Weaver seconded, and the motion was carried unanimously.

Colonel Holland resumed the chair, and briefly returned thanks on behalf of Mr. Meier and himself for the honour that had been done to them.

The Hon. R. Grimston, seconded by Major Wood, moved that the auditors be re-elected for the year. The motion was carried unanimously.

Mr. Ford, in moving a vote of thanks to the chair, said that his pleasure in being present that day had only one alloy, and that was that the meeting had taken place on Saturday at 12. He hoped that in future that little matter would be rectified. Mr. K. Anderson seconded the motion, which was carried by acclamation.

The Chairman, in replying, explained that the day of their meeting was a disagreeable necessity. We could only get our accounts posted up by a certain day in the course of this month, and we were bound to meet by the end of April, so that we were absolutely in this corner, that unless we met on the Saturday or the Sunday, which I suppose would be still more strongly objected to, we could have held no meeting at all. (Laughter.) He trusted the awkwardness would not occur again. He begged to thank them most cordially for their vote of thanks.

THE GERMAN UNION TELEGRAPH AND TRUST COMPANY, LIMITED.

THE eleventh ordinary general meeting of this company was held last week at the offices, Old Broad Street. Sir James Anderson presided, and stated that the new cable between Greitseel, in Germany, and Valentia, in Ireland, had been successfully laid since their last meeting, and had then been opened for traffic four days. They must wait for another year to see the results attending it. There was no doubt, however, that a direct cable for Germany had to be laid, and he thought they had been fortunate in securing the concession. It was originally thought that the cost of the cable would be about £165,000, but owing to the competition and the good management of the German directors, the outlay had been £20,000 within that estimate. If they had had the cable in the winter, it would have saved them the loss they had sustained of their American traffic owing to the breakage of their original cable. Their other traffic they had had secured to them by the arrangements which had been made with the Post Office and the Submarine Telegraph Company. The German directors, with the concurrence of the English Board, had decided to put by an additional 5 per cent. out of revenue (or about £2,000) to the reserve fund until it got back to the amount at which it stood last year, £30,000. That would probably tend to reduce their dividends for a year or two, but to that they must submit in order to render their property well secured and efficient. He concluded by moving the adoption of the report and accounts, and the declaration of a dividend of 6s. 9d. a share, making with the previous dividend of 5s. 9d. a share, 6¼ per cent. for the year. Count Oscar von Reichenbach having seconded the motion, the chairman in reply to Mr. Pender, M.P., and Mr. W. Griffith, stated that neither the English nor the German law allowed them to pay back the £20,000 referred to; and being capital, they could not place it to the reserve fund. The motion was carried unanimously, and the retiring director and auditor were re-elected.

THE BRAZILIAN SUBMARINE TELEGRAPH COMPANY, LIMITED.

THE report of the directors states that the revenue for the half year ended December 31st, 1881, amounted to £86,692 18s.; the working expenses to £12,467 12s. 11d., leaving a balance of £74,225 5s. 1d.; to this is added £4,510 17s. 6d., brought forward from June 30th, 1881, making a total of £78,736 2s. 7d. After deducting income tax, £1,025 10s. 6d., there remains a balance of £77,710 12s. 1d. First and second interim dividends amounting to £39,000 have been distributed, leaving the sum of £38,710 12s. 1d. to be carried forward. Since December 31st last a further sum of £39,935 14s. 4d. has been invested on account of the reserve fund. It being found necessary to remove a fault which appeared in the shore end of the cable at Pernambuco, the repair was successfully effected by the Telegraph Construction and Maintenance Company's steamer *Kangaroo*, with only a slight delay to the traffic. The electrical tests of this section show that the entire deep-sea portion is absolutely perfect and as good in insulation as when first laid. The company's cables continue in good working order. The directors regret to announce the resignation of Mr. de Andrade Pinto from the pressure of other engagements. The vacancy will be filled up by the appointment of a representative in Brazil in accordance with Art. 27 of concession. The traffic receipts for the year 1874-5 amounted to £148,461; 1875-6, £129,038; 1876-7, £131,507; 1877-8, £104,003; 1878-9, £139,654; 1879-80, £154,957; 1880-81, £167,350.

SUBMARINE CABLES TRUST.—The report of the trustees states that the revenue for the twelve months ended April 15th, 1882, including the balance brought from last year's accounts, viz., £777 3s., and the dividend on Eastern Extension shares (£2,323 13s.), declared prior to the 15th but not paid until 20th instant, amounted to £23,535 11s. 3d. The expenses of the trust amounted to £1,316 0s. 8d. Payment of two coupons at the usual rate of 6 per cent. per annum has absorbed £20,382, and the balance of £1,837 10s. 7d. is carried forward. Since the issue of the last report no change has been made in the securities of the trust. In consequence of the lamented death of Mr. William Newmarch, F.R.S., who was reappointed an auditor of the trust at the last annual meeting of certificate holders, the accounts now presented bear only one signature, viz., that of Mr. J. G. Griffiths, of the firm of Deloitte, Dever, Griffiths & Co. It rests with the meeting to elect two auditors for the current year.

THE DIRECT UNITED STATES CABLE COMPANY, LIMITED.—We are informed that the board have resolved upon the payment of an interim dividend of five shillings per share, being at the rate of five per cent. per annum for the quarter ending 31st March, 1882, such dividend to be payable on and after the 16th instant.

LATEST QUOTATIONS.

Authorised Issue.	Share.	Name.	Paid.	Closing Quotations. May 3.	Business Done.
		ELECTRIC LIGHT.			
40,000	10	Anglo-American Brush Co.	4	13¼-13⅝	13¼.⅜.¼.¼.⅝.
		Do. Do.	10	31 - 32	32.1.2.1¼.⅜
150,000	1	Electric Light and Power Generator Co.	1	⅜- 1	15/16.1.01/16
		TELEGRAPHS.			
2,116,400*l.*	Stk.	Anglo-American, Limited	100	54⅞- 55½	54.¼
2,441,800*l.*	Stk.	Do. Preferred Def'd. receiving no div. until	100	85½- 86½	85⅞.5/16.6.5.6½
2,441,800*l.*	Stk.	Do. Deferred 6 p. c. has been paid to Pref.	100	24½- 25	24½.⅞
130,000	10	Brazilian Submarine, Limited	10	11 - 11¼	11¼
16,000	10	Cuba, Limited	10	8½- 9	
6,000	10	Do. 10 per cent. Preference	10	15½- 16½	
13,000	10	Direct Spanish, Limited	9	5⅛- 5⅜	
6,000	10	Do. 10 per cent. Preference	10	14½ 15½	
65,000	20	Direct United States Cable, Limited, 1877	20	11⅛- 12	11⅝
100,000*l.*	100	Do. 6 per cent. Debenture, repayable 1884	100	101 -104	102
380,000	10	Eastern, Limited	10	10 - 10½	10 5/16.⅜.¼
70,000	10	Do. 6 per cent. Preference	10	12⅝- 13	
232,000*l.*	100	Do. 6 do. Debentures, repayable Oct. 1883	100	99 -102	
200,000*l.*	100	Do. 5 do. do. Aug. 1887	100	101 -104	
200,000*l.*	100	Do. 5 do. do. Aug. 1899	100	102 -107	
199,750	10	Eastern Extension, Australasia & China, Limited	10	11½- 11⅝	xd. & bonus
320,000	100	Do. 6 p. c. Debentures, repayable Feb. 1891	103	106 -110	
500,000	100	Do. 5 p. c. (Australian Gov. Subsidy) Deb. 1900	100	103 -106	
140,000	100	Do. do. registered, repayable 1900	100	103 -106	
100,000*l.*	100	Do. 5 per cent. Debenture, 1890	100	101 -104	
254,300*l.*	100	Eastern and South African Limited 5 per cent. Mort. Deb. Registered redeemable 1 Jan. 1900	100	103 -106	
345,700*l.*	100	Do. do. To Bearer	100	103 -106	
22,050	10	German Union Telegraph and Trust, Limited	10	9½- 10	
163,390	10	Globe Telegraph and Trust, Limited	10	6⅜- 6⅝	6.5/16.⅜
163,209	10	Do. 6 per cent. Preference	10	12½- 12⅝	12 7/16.5/16.⅜
125,000	10	Great Northern	10	12⅝- 13¼	13¼*
100,000*l.*	100	Do. 5 per cent. Debentures	100	102 -105	
31,200	10	India-Rubber, Gutta-Percha and Telegraph Works	10	25 - 26	25⅜.5/16
100,000	100	Do. 6 per cent. Debentures, 1886	100	101 -105	
17,000	25	Indo-European, Limited	25	30 - 31	
38,148	10	London Platino-Brazilian, Limited	10	4⅛- 5	
12,060	10	Mediterranean Extension, Limited	10	1⅞- 2⅛	
8,200	10	Do. 8 per cent. Preference	10	8⅛- 9	
9,000	8	Reuter's, Limited	8	13 - 13⅛	13 xd.
280,000	Stk.	Submarine	100	260 -270	
58,225	1	Do. Scrip	1	2⅛- 2⅜	
4,200	Cert.	Submarine Cables Trust	100	103 -106	
37,350	12	Telegraph Construction and Maintenance	12	30 - 31	30⅛.¼
150,000	100	Do. 6 per cent. Bonds, 1884	100	102 -105	103⅜
186,750	5	Do. 2nd Bonus Trust Cert.	5	1⅛- 1⅜	
30,000	10	West Coast of America, Limited	10	5⅛- 5¼	
150,000	100	Do. 8 per cent. Debentures			
69,910	20	Western and Brazilian, Limited	20	8 - 8⅛	8
200,000*l.*	100	Do. 6 per cent. Debentures "A" 1910	100	107 -112	109.8⅛
2,500	100	Do. 6 p.c. Mort. Deb. series B of '80, red. Feb., 1910	100	99 -102	
1,500	$1,000	Western Union of U. S. 7 p.c. 1 Mort. (Building) Bds.	$1,000	121 -126	xd.
1,039,000*l.*	100	Do. 6 per cent. Sterling Bonds	100	102 -105	
88,321	10	West India and Panama, Limited	10	1⅞- 2	
34,563	10	Do. 6 per cent. 1st Preference	10	8⅞- 9	
4,669	10	Do. 6 do. 2nd do.	10	6⅞- 7⅛	
		TELEPHONES.			
154,165	1	Con. Telephone & Maintenance, Ld. Nos. 1 to 154,165	1	1⅛- 1⅜	11 1/16.⅜ xd.
200,000	1	Oriental Telephone Co.	1	⅜- ½	
100,000	5	United Telephone Co.	5	13⅛- 13⅜	13 5/16.⅜.⅜

* Exceptional amount at special price.

THE CRYSTAL PALACE ELECTRICAL EXHIBITION.—It is proposed that the Electrical Exhibit should come to a termination on the 3rd June next. As far as the electric light is concerned this step appears advisable, as then the evenings will be naturally light almost as late as the palace keeps open. The remaining part of the exhibition, however, will not present any great attraction to the general public, and we do not imagine that the exhibitors themselves will feel particularly disappointed at its premature close. Will the Palace Directors select any of the systems for the light which may be permanently required, or will gas make its reappearance?

THE TELEPHONE CASE.

In the High Court of Justice. Chancery Division.

Before MR. JUSTICE FRY.

THE UNITED TELEPHONE COMPANY, LIMITED,

v.

HARRISON, COX-WALKER & Co.

THIS action is brought by the plaintiff company against the defendants, and the claim put forward by the company is that it possesses the various letters-patent taken out by Bell and Edison for telephone receivers and transmitters respectively, and the defendants are charged with being infringers of these letters-patent. The case is similar in many respects to that recently decided in Scotland by Lord M'Laren, and which was specially and fully reported for the ELECTRICAL REVIEW. It will not therefore be necessary to put before our readers a reprint of the claims of the plaintiff company, as they are now well known. Neither is it needful to dwell upon the affidavits of Sir Frederick Bramwell, Sir William Thomson, and the solicitors to the company, which are to the effect that the "Hunnings transmitter" and the "Electrophone receiver" of Cox-Walker, which are the instruments complained of, contain nothing essentially different to the various forms of telephone apparatus respectively described by Edison and Bell in their specifications, and that they are therefore infringements of the plaintiff's letters-patent. The Statement of Defence, however, is contained in the *particulars of objections*, which we reprint as far as we think them important, or will prove interesting.

PARTICULARS OF OBJECTIONS.

As regards the said letters-patent granted to the said William Morgan-Brown on December 9th, 1876, No. 4,765, in the Statement of Claim mentioned, the defendants will contend:

That the alleged invention claimed in the amended specification of the said alleged letters-patent is not one for which letters-patent can lawfully be granted.

The alleged invention claimed in the amended specification is a different invention from that for which the said supposed letters-patent were granted, and is not an invention corresponding to the title of the said letters-patent.

The said amended specification is insufficient.

The said amended specification does not sufficiently distinguish what part of the said invention is new and what part is old.

The said disclaimer and memorandum of alteration extends the alleged exclusive right granted by the said alleged letters-patent.

The said William Morgan-Brown was not the true and first inventor or the first importer into her Majesty's realm of the alleged invention claimed in the said amended specification.

The alleged invention claimed in the said amended specification was not at the date of the said supposed letters-patent new as to any public knowledge, use, and exercise thereof within her Majesty's realm, and is not, nor is any part of it, useful.

That the said supposed invention, or material parts thereof, had been before the date of the said letters-patent published in her Majesty's realm by the printing and publishing of the several specifications and books and papers hereinafter mentioned, that is to say:

The specification of letters-patent granted to Cromwell Fleetwood Varley for an invention of "Improvements in Electric Telegraphs," bearing date April 8th, 1870, No. 1,044, so far as the same relates to a method of, and apparatus for, superposing upon the currents used for working ordinary telegraphs rapid undulations or waves, which produce distinct and audible signals, whether ordinary signal currents be flowing or not, by reference to pages 4 and 5 and page 6, lines 1-15, and page 7, lines 13-20.

The specification of letters-patent granted to Edwin Chabot, executor of George Tomlinson Bousfield, for an invention relating to Electro-Harmonic Telegraphs, bearing date May 4th, 1876, No. 1,874, so far as the same relates to the transmission of a smooth current and one or more vibratory waves simultaneously through a circuit, and to apparatus described in the said specification and shown in figs. 2, 3, and 4.

The specification of letters-patent granted to John Henry Johnson for an invention relating to the transmission of musical tones by electricity, bearing date July 29th, 1874, No. 2,646.

The specification of letters-patent granted to John Henry Johnson for an invention of apparatus for transmitting musical vibrations, bearing date March 16th, 1875, No. 974, so far as the same relates to an apparatus known as a telephone.

The specification of letters-patent granted to Peter Jensen and dated September 2nd, 1874, No. 2,999, for an invention of improvements in transmitting and printing telegraphic messages, and in apparatus therefor.

The specification of letters-patent granted to Peter Jensen and dated February 29th, 1876, No. 843, for an invention of improvements in telegraphy.

The specification of letters patent, No. 174,465, dated March 7th, 1876, granted in the United States of America to Alexander Graham Bell, and contained in the monthly volume of full specifications and of drawings issued by the Patent Office of the United States, a copy of which publication was deposited in, and open for public inspection at, the library of the Great Seal Patent Office, prior to the date of the said letters-patent granted to the said William Morgan-Brown, A.D. 1876, No. 4,765.

An abridgment of the last-named specification of Alexander Graham Bell, with drawings and claims in full, contained in Vol. 9 of the Official Gazette of the United States Patent Office, No. 174,465, copies of which publication were prior to the date of the said letters patent of A.D. 1876, No. 4,765, deposited and open for public inspection at the Central Free Library, Ratcliffe Place, Birmingham, in the county of Warwick; in the Leeds Public Library at Leeds; and at Stubbs' Mercantile Offices, 12, Gresham Street, in the City of London; and were also prior to the same date sent to the following patent agents and others in England, viz., J. T. King, 4, Clayton Street, Liverpool; W. Lloyd Wise, Chandos Chambers, Buckingham Street, Adelphi, London; Edward Cope, 17, Arboretum Street, Nottingham; Herbert & Co., 67, Strand, London; Newton & Son, 66, Chancery Lane, London; Tangye Brothers, Birmingham.

The *English Mechanic and World of Science*, published in London, No. 594, of the 11th August, 1876, containing an article herein referred to headed "Experiments in Telephony," also an article in the same paper published on the 26th November, 1875, containing an account of La Cour's musical telegraph.

Nature, of September 14th, 1876, published in London, containing an opening address by Sir W. Thomson at the meeting of the British Association at Glasgow, and also by the address of the said Sir W. Thomson at the aforesaid meeting held in Glasgow in the month of August, 1876.

A paper on researches in telephony, by Alexander Graham Bell, presented on May 10th, 1876, and published in the "Proceedings of the American Academy of Arts and Sciences," copies of which publication were deposited in the reading room and library of the Royal Society, London, and of other learned societies in the United Kingdom prior to the date of the said letters-patent.

The TELEGRAPHIC JOURNAL, published in London by Haughton and Co., Paternoster Row, of December 15th, 1875, containing an article on transmitting musical tones by electricity; and the same for May 15th, 1876, pages 148-9, containing an article by P. H. Vander Weyde; and the same for October 1st, 1876, containing an article relating to a summary of Electrical science at the British Association.

The *Scientific American*, published in London, containing on September 9th, 1876, an article on the human voice transmitted by telegraph, and in the supplement to same paper for 5th February, 1876, containing an article by Elisha Gray on the transmission of musical tones telegraphically.

"Zeitschrift des Deutsch—ös terrachischen Telegraphen Vereins," Tahngang 9, 1862, containing a description by Legat, with plate on "reproduction von tonen, &c.," which book was deposited in and open for public inspection at the library of the Great Seal Patent Office, London, prior to the date of the said letters-patent.

Report on Awards, Group XXV., Centennial Exhibition, Philadelphia, in the United States of America, for 1876, pages 130, 131. The said report was made by Sir W. Thomson, Joseph Henry, and others, and was deposited in the reading room and library of the Society of Telegraph Engineers, London, prior to the date of the said letters-patent.

The *New York Tribune*, of November 9th, 1876, containing an article on Sir W. Thomson's exhibition of telephones at the Glasgow meeting of the British Association.

The said alleged invention, or material parts thereof, had been, prior to the date of the said letters-patent, publicly used and published at the places hereinafter named in manner following, that is to say: by the exhibition and use by Sir W. Thomson at the meeting of the British Association at Glasgow, in August, 1876, of telephonic apparatus made as described in the said amended specification, and also by the exhibition and use of such telephonic apparatus as aforesaid in the College of Glasgow.

And as regards the said alleged letters-patent granted to the said Thomas Alva Edison on June 30th, 1877, No. 2,909, in the statement of claim mentioned, the defendants will contend:

That the alleged invention claimed in the amended specification of the said alleged letters-patent is not one for which letters-patent can lawfully be granted:

The said alleged invention, as specified and as claimed in the said amended specification, is a different invention from that for which the said alleged letters-patent were granted, and comprises subject matter other than that for which the said alleged letters-patent were granted, and is not an invention corresponding to and comprised within the title and provisional specification of the said letters-patent.

The said amended specification does not sufficiently distinguish what part of the said supposed invention is new and what part is old.

The said disclaimers and memoranda of alteration extend and each of them respectively extends the alleged exclusive right granted by the said alleged letters-patent.

The said Thomas Alva Edison was not the true and first inventor of the alleged invention claimed in the said amended specification.

The said alleged invention claimed in the said amended specification was not, at the date of the said letters-patent, new as to any public knowledge, use, and exercise thereof within her Majesty's realm, and is not, nor is any part of it, useful.

That the said supposed invention, or material parts thereof, had been before the date of the said letters-patent published in her Majesty's realm by the printing and publishing of the several specifications and books and papers, as well those hereinbefore mentioned as prior publications of the said supposed invention patented by the said William Morgan-Brown on December 9th, 1876, No. 4,765, as those hereinafter mentioned, that is to say:

The specification of letters-patent, No. 141,777, dated August 12th, 1873, granted in the United States of America to Thomas Alva Edison, a copy of which publication was deposited in, and open for public inspection at, the library of the Great Seal Patent Office prior to the date of the said letters-patent.

A copy of the *Philadelphia Press*, published on the 9th July, 1877, in the city of Philadelphia, in the United States of America, and for-

warded in due course of post to the American Exchange in London, where it was accessible to the public on or about July 19th, 1877, and before the date of the said letters-patent.

A treatise by the Comte Du Moncel, entitled "Exposé des Applications de l'Electricité," second edition, vol. 1, page 246, published at Paris A.D. 1856.

An account of Reis's telephone, published by W. and R. Chambers, London and Edinburgh, A.D. 1867, in Ferguson's "Electricity," pages 257, 258.

The specification of letters-patent, No. 158,787, dated 19th January, 1875, granted in the United States of America to Thomas Alva Edison, for an invention of an electro-motograph, which said specification was deposited in, and open for public inspection at, the library of the Great Seal Patent Office, London, prior to the date of the said letters-patent and was also prior to the same date published in this country in an abridged form in the Official Gazette of the United States Patent Office, vol. 7, page 98.

A treatise of Electricity, by J. T. Sprague, published by E. and F. N. Spon, at 48, Charing Cross, London, A.D. 1875, in a note on the conducting power of carbon at page 104.

The said alleged invention or material parts thereof had been prior to the date of the said letters-patent publicly used and published at the places hereinafter mentioned in manner following, that is to say:

By the manufacture and sale and use before the date of the said letters-patent of telephones known as Reis's telephones at 11, Beak Street, Regent Street, London, by William Ladd, instrument maker.

The defendants reserve the right to add to these particulars any other particulars which may come to their knowledge.

The opening speech of Mr. Aston, Q.C., for the plaintiffs, occupied the greater part of Monday, the 24th of last month, the date on which the trial commenced. The address of the learned counsel was a very exhaustive one, but at the same time rather laboured, and leading one to imagine that he did not feel quite at home with his subject. We do not, however, intend to deal further with this, as we feel convinced that from a general reader's standpoint the scientific evidence of the numerous eminent witnesses engaged on both sides will be most acceptable, and we therefore purpose giving the principal facts connected with the examination of each individual. Sir Frederick Bramwell, who was the first witness called for the plaintiffs, almost at the end of the first day, was examined by Mr. Aston. He said he had been connected with electric telegraphs for many years, and was acquainted with the telephone. Shortly after the commencement of the discoveries in America he began to take an interest in them, but not a particular interest. Since then he had examined into the various telephones, and might say he was acquainted with the existing state of knowledge concerning them. Prior to the discoveries in America there had been certain inventions for the transmission of sound, but no telephone or electrical instrument capable of transmitting articulate speech, *so far as he knew*, although he was aware that the reverse had been stated. Some drawings of forms of telephones, on plans 4 and 5 of Bell's specifications, being handed to witness, he explained their operation as being due to a battery being in the circuit in the case of plan 4, and to the introduction of two permanent magnets in plan 5.

Examined by Mr. WEBSTER, Q.C.

Sir Frederick Bramwell, continuing his evidence, commenced by describing the different parts of the Bell telephone, and pointed out how the movement of the metal diaphragm, acting on the magnetic field, produced currents in the insulated wire surrounding the pole of the magnet, and explained how the same apparatus would act both as a receiver and as a transmitter.

In answer to Mr. Justice Fry's question, it was said by Sir Frederick, as an expert, that Morgan-Brown's specification was sufficient to enable a competent electrician to construct a telephone. A long controversy then took place between Mr. Justice Fry, witness, and counsel, upon undulatory, pulsatory, &c., currents, and it was explained that when a permanent magnet is caused to vibrate in front of the pole of an electro-magnet, an undulatory current of electricity is induced in the coils of the latter, and the action of the iron diaphragm in a Bell's telephone produces an analogous effect. In the case where an electro-magnet is used instead of a permanent magnet, the undulations become superimposed upon the permanent current produced by the battery; the forms of these undulations being, however, the same as those produced where permanent magnetism is employed. The Cox-Walker Electrophone receiver was then considered and was declared to be in all its parts similar to that of Bell. This would act as a transmitter also, though, in fact, it was only used as a *receiver*, upon which point the defendants were charged as infringers of Bell's patent. Sir Frederick then described the apparatus as follows:—I find here a plate capable of inductive action, supported all round its edges in the neighbourhood of the poles and within the magnetic field of an electro-magnet made so by a current coming to it from the line wire at the plate, therefore capable of responding to the variations in the current which may come along the line wire from a suitable transmitting instrument, and capable therefore of producing articulate speech.

In answer to a question whether the apparatus brought by Sir William Thomson from America would work, the witness said that he did not think it would act. In his opinion, as a scientific gentleman, the apparatus referred to was not the same as the Bell or Cox-Walker receiver now exhibited in Court. The Hickley receiver was next touched upon, which the witness explained in detail, and gave as his opinion that it was substantially the same as Bell's.

The Edison carbon transmitter was the next subject of examination. The tension regulator of this instrument was described as being made of something of semi-conductivity, such as lamp-black, plumbago, or materials of elastic character, which can be brought nearer together and will reassert themselves when that which brought them together is removed; a diaphragm being employed to produce more or less pressure upon these materials by the action of the voice. The action of the current was here compared at some considerable length with that of water flowing through a pipe. A portion of Edison's specification was then quoted as follows:—I find that it is not practical to open and close the line circuits in instruments for transmitting the human voice; the circuit to the line must be always closed, and the transmission be produced by a rise and fall of electric tension, resulting from more or less resistance in the line. This resistance may be produced in several ways. I have shown several which will hereafter be named, but I find the most delicate to be small branches or tufts, or discs of semi-conducting elastic fibre, such as particles of silk, and an intermediate conducting or semi-conducting material; this device I call an electric tension regulator; it is more or less compressed according to the vibrations of the diaphragm or tympan, and the electric current rises in tension as it is compressed, or lessens as the fibre expands. It was pointed out that in describing the action of his apparatus the term *compression* was used as explaining the action of the diaphragm upon the semi-conducting material, the material being in fact squeezed between the diaphragm and a spring. In answer to Mr. Justice Fry the witness said: "If you take a stick of carbon and press on the end of that stick, I believe there is a result arising, a very great result arising, from a very small variation of pressure on the end of that stick, but I do not suppose I have thereby compressed the stick of carbon throughout. I believe the effect of the pressure is due to that which takes place at the surface of contact."

In Edison's specification the following passage occurs:—"In some cases I make use of a variable resistance resulting from greater or less intimacy of surface contact, such as would result from a disc covered with plumbago placed adjacent to a diaphragm also covered with plumbago or other semi-conducting material." The witness thought that Clerac's tube was used for producing a permanent alteration of resistance, and not for a continuous variation. The Hunnings transmitter was then described by the witness, who came to the conclusion that it was substantially the same as Edison's, that is, he obtains the same end by substantially the same means. He considered that powdered or crushed coke effected the same purpose as compressed or powdered plumbago. The substitution of coke for lamp-black or plumbago would follow from the discovery of Edison.

In the cross-examination of Sir Frederick by Mr. Pearson, Q.C., it was explained that, although a regulating screw was used in the Edison transmitter, it was not essential to the working of the apparatus. Clerac's tube could not be considered as a tension regulator in the sense of Edison's specification. The apparatus of Reiss was next brought forward, and its general construction explained. It was shown that on the instrument there was a diaphragm, and that the contact points were provided with a spring and an adjusting screw. In answer to the question whether the transmitter acted as a tension regulator, Sir Frederick said that it did not, since it worked by a broken circuit, and not by a closed one; and the description in the original German distinctly stated that such was the action. Although Edison in his patent described an apparatus somewhat similar to that of Reis's, that is, an apparatus in which two platinum surfaces were employed, he disclaimed this. The continuity of the circuit in this instrument was kept up by means of a shunt between the platinum surfaces. The Reis receiver, which was next examined, consisted of an electro-magnet, with a vibrating plate. In reply to Mr. Justice Fry, Sir Frederick said that this receiver, "if it speaks, speaks in the same manner as the receiver of Bell, to this extent, that it vibrates backwards and forwards to a certain extent in obedience to the variations of the electric currents. But this answer requires qualification, inasmuch as the touch is kept up by the adjusting screw and spring. I believe it would have its own time of vibrations; but I believe it would not be capable of the multiple of vibrations required for successful speech." Gray's receiver, Sir Frederick considered, might probably reproduce speech. The action of the phonograph was next considered as to whether it might be called an actual transmitter.

In the re-examination by Mr. Webster, Sir Frederick said that the Hunnings transmitter has practically to be adjusted by proportioning the amount of powdered carbon inserted in it. Edison's specification points out that semi-conducting substances should be exclusively used for the purpose of his regulator. Returning again to the Reiss apparatus, the witness said that the instrument could not reproduce articulate speech, unless it acted in a way not contemplated by the inventor. If the contact points were dirty, it might act as a tension regulator.

At the conclusion of Sir Frederick Bramwell's evidence, Sir William Thomson was examined by Mr. Aston. The witness considered the contrivances described by Bell in the specification of his patent of December, 1876, to be new. He had seen when in America the apparatus of Professor Bell, in which the receiver was an electro-magnet with an iron cylinder round it, and with a flexible iron disc. Sir William was then examined with reference to the description he had given of the apparatus at the British Association meeting at Glasgow, in September, 1876. He there stated that he had heard words spoken with unmistakable distinctness by a "thin circular disc armature." The apparatus he had exhibited at the Glasgow meeting was not joined up in working order. From the attempts he had made to cause the apparatus to speak, he had concluded that the latter was not of practical use. The witness did not know of any case in which lamp-black or plumbago was employed for the transmission of vocal sounds previous to the discoveries of Edison; the fact of carbon being a semi-conductor was known a long time ago.

Sir William Thomson, in answer to Mr. Justice Fry, as to the medium required to be used in an Edison telephone for the purpose of varying the current, said it must be a substance of considerable resistance, in fact, semi-conductive. When questioned as to whether it must be of such a quality that under pressure its resistance is diminished, Sir William said that is not necessary in respect to the substance itself, but in respect to the resistance due to the transi-

tion between two portions of the substance, or between one substance and another substance.

Either the substance itself or the surface of that and the other substance ought, under pressure, to diminish the resistance?—Yes; increasing the resistance, vary the resistance under varying pressure.

That is, with the increase of pressure the resistance is diminished. Is that right?—Yes.

It must be of such a character that either the pressure of the substance, one or the other, or the particles of that substance on the adjoining substance diminishes the resistance?—Yes.

In the third place it must have this quality, that it must be capable either in itself, or by force of some arrangement, of recovering its previous position?—Yes.

Those three qualities are all essential to the success of the interposed substance?—Yes, they are all essential.

To follow it up, the non-conductivity of bodies, or the power of resistance of bodies, was a well-known quality of substance in 1876?—Yes.

But were the other two qualities well known also?—Not so well known as they are now.

But were they known at all except as regards your experiments on metals?—My experiments scarcely bear on the actual subject; they bear on something that has been confounded with the actual subject.

What is passing through my mind is this, that although carbon in one form may be the equivalent of carbon in another form as regards conductivity, it does not, I suppose, follow it is the equivalent of carbon in the other form as regards its power of varying under pressure?—Yes, it follows, certainly.

Is that a known thing?—It is a known thing now: known to myself from my own experiments.

Was it known then?—No.

By Mr. ASTON: Take Edison's specification into your hand and direct your attention, if you please, to page 5, line 21, or take line 20:—"The circuit to the line must be always closed and the transmission be produced by a rise and fall of electric tension, resulting from more or less resistance in the line. This resistance may be produced in several ways. I have shown several, which will hereafter be named, but I find the most delicate to be small bunches, or tufts, or discs, of semi-conducting elastic fibre, such as particles of silk, and an intermediate conducting or semi-conducting material. This device I call an electric tension regulator. It is more or less compressed, according to the vibrations of the diaphragm or tympan, and the electric current rises in tension as it is compressed, or lessens as the fibre expands. This fibre is placed in a small roll, *t*, between the delicate diaphragm spring, *u*, fig. 9, and the variable presser, *v*, adjustable by screen or otherwise, in the electric circuit at this point, or it may be within a cavity in said presser, *v*, as in fig. 1, there being a delicate cork centre-piece, *w*, to the diaphragm, *b*, with a piece of platina foil, *x*, in contact with the fibre. In all instances the telegraphic circuit at the diaphragm is made by a thin strip of platina, or similar material, extending to the centre from the line or battery connection. The fibre is rendered semi-conductive by being rubbed with plumbago, soft metal, or similar material, or by a deposit of metal upon its surface, or by fine particles of conducting or semi-conducting material mixed with it." Then on page 6: "In some cases I make use of a variable resistance," I have read that before, "resulting from greater or less intimacy of surface contact, such as would result from a disc covered with plumbago or other semi-conducting material, so that the proximity or extent of surface contact will produce rise and fall of tension, the respective parts being in the telegraphic circuit." Now, as far as those instances are concerned, do those instances, according to the meaning you, as an electrician, attribute to the expressions, include or exclude the diamond?—They exclude the diamond, certainly, because the diamond is an insulator. It is so good an insulator, that if a diamond is rubbed it will attract a small piece of paper, as amber or sealing-wax does.

Would those expressions to the mind of an electrician convey a meaning?

Mr. JUSTICE FRY: That is not the question; it is not what they convey now.

Mr. ASTON: What would they have done in 1877; would they in 1877 have been any such guide? I will put it that way, and if so what guide to a person who desired to make the apparatus described by Edison, and use it in the way he describes to effect the purpose he describes?—It would have guided him to use small particles of semi-conducting material, and to place them in such a manner without any pressure of proximity or extent of the surface of contact. I should rather say simply the extent of the surface of contact would be varied by the pressure, and therefore the resistance in a closed circuit varied.

And having regard to the language, what are the substances which, in your opinion, he would in all probability first try?

Mr. HEMMING: This is putting it rather strongly.—From the example stated I have no doubt——

Mr. ASTON: If my learned friend objects, I put it to your lordship whether it is right.

Mr. JUSTICE FRY: I have heard no objection.

Mr. HEMMING: I do not want to strain technical objections.

Mr. JUSTICE FRY: I do not attend to all the undertones that pass; it must be an articulate utterance before I do.—It seems to me that semi-conductive is a word which is logically clear in its signification, but somewhat indefinite; it means that it is a quantity the virtue of which consists in its being conductive, but not conductive to the highest degree; therefore I should say, taking a logical interpretation such as an intelligent workman would take of this specification, he would take some material which is not the very best possible conductor, but some material whose resistance in the circuit would sensibly increase the whole resistance. If he knew anything about the electric light, the carbon pencils of the electric light, he would scarcely fail to take powdered coke in some form, especially when guided by the indication that lampblack, one form of powdered charcoal—graphite compressed—the best and purest form of carbon; and both were actually used by Edison and described in the specification—

You think he would have taken carbon?—Yes.

Is it not a remarkable fact the patentee does not take it? You tell me that a skilful workman would have taken carbon; but the patentee does not take it.—It is one of the things he would take; he may take other things; perhaps the patentee took platinum, and he would have succeeded then.

He does not mention charcoal?—Which patentee?

Edison. If I followed you rightly, you think an intelligent workman reading Edison's patent would have taken charcoal.—Most probably he would have taken graphite if he could get it. If not, he would take the next thing to it—gas coke. Graphite is difficult and expensive to get. He would have taken graphite if he could get it. It says graphite. If I cannot get graphite I will take the next best thing—gas coke.

I thought you spoke of charcoal?—Gas coke is charcoal.

I mean charcoal in the vegetable form?—I did not mean that, because in 1877 it became pretty well known that ordinary vegetable charcoal was not very good for the carbon pencil of the electric arc, not nearly so good as coke.

Mr. ASTON: Forgive me for putting a question which is almost unnecessary, graphite is plumbago, is it not?—Yes.

You use the term, and the two are synonymous?—Yes, I mean plumbago.

Mr. HEMMING: We understand that is the sense in which Sir William is using it, but I believe it is sometimes used in Germany and elsewhere to include other things beside plumbago, to include gas coke in fact?—I was not aware of that.

We take it that you use it in that sense?—Graphite is synonymous with plumbago; I should have said plumbago, but I am more accustomed to call it graphite.

You are using it in the sense of plumbago?—Yes, I am more accustomed to call it graphite, but plumbago is identical.

Mr. ASTON: My other question is, is it not true that lampblack is chemically a form of charcoal?—Yes.

It is charcoal; lampblack is a substance consisting of charred carbonaceous particles?—Yes.

Charcoal is a substance consisting of charred carbonaceous particles?—Yes.

The particles in the lampblack are in size, as we ordinarily see it, probably smaller than the particles of charcoal or coke?—Yes.

Mr. JUSTICE FRY: Are there not impurities in lampblack which do not exist in gas coke, for instance?—There may or may not be, I believe. There may be nitrates produced from some substances—from others it may be pure; with the pure hydro-carbon flame you get the purest form of carbon.

In many cases there are impurities?—In many kinds of soots there are ammonia and other things, but the kind of lampblack that probably would be chosen would be the lampblack from a hydro-carbon flame, and that, I imagine, would be exceedingly pure charcoal.

Mr. ASTON: Then, assuming you will find, as you will if you were to look a little lower down, that Edison tells you to use the best lampblack, you attach a value to the adjective "best"?—I did not think of that when I spoke, but, now you tell me he attaches that adjective, I should say it would be the purest that would be meant.

My lord asked you whether there were impurities that are found in lampblack. Are you able to say whether it is not a fact also, that in the distilling process, you may have impurities which get mixed with gas coke?—Yes, certainly—considerable impurities.

Therefore, in both cases, the impurities, to the extent they are there, it would be desirable to eliminate?—Yes, in gas coke there is a great deal of ash which does not exist in lampblack, or in pure plumbago.

Therefore, whatever would have to be guarded against in the one form of carbon, if necessary, would have to be in the other form of carbon, as regards impurities if necessary?—Yes; but it does not seem any very special provision is necessary; all that seems necessary is, that the impurities do not rise to such a degree as to give it too little of conductivity. A mixture of non-conducting substances would not impair the action if we do not take away the whole conductivity, and make it a broken circuit.

Sir William then examined the Hunnings transmitter, and, comparing it with the description of Edison's specification, he declared it was to all practical and theoretical aspects identical with one of Edison's forms, and that they were both designed to produce the same effect by precisely the same physical means. The witness further stated that in his opinion Edison's specification was one that described the nature of the inventions in an intelligible manner, and that a person of ordinary acquaintance with the subject matter would understand it. Sir William then said he had read and made himself acquainted with Bell's specification, and that it also, in his opinion, intelligibly and sufficiently described the nature of the invention and the manner in which it could be performed, so that a person of ordinary intelligence would understand it. In comparing the Bell receiver with the Cox-Walker receiver, the witness said they were obviously adapted for the same purpose, and that he found it (the Cox-Walker receiver) described in Bell's specification as one of the plans he proposed to employ for the purpose of transmitting articulate sounds. In regard to the Hickley receiver it answered the same purpose as the Bell, and as regards the means employed there was no difference that he could point out.

Cross-examined by Mr. Hemming in regard to the claims in the original specification of Bell, the witness knew he had disclaimed a good many things in his specification as old, and that he had disclaimed some things which were not old. In reference to the Glasgow instruments, the witness stated that he had brought a pair of instruments to Glasgow, a transmitter and receiver, but in that form of instrument the two were essentially different, and were not, like Bell's subsequent instruments, interchangeable. He asserted that neither

himself nor his assistants could make anything of these instruments, and he did not believe that the instruments as they stood would even work, but if he and his assistants had had three years' experience with the telephone, especially with the knowledge we now have, they might even have made those instruments work. They were obviously not practically useful instruments, and it was obvious a new invention was necessary before they could be so. In reference to the Philadelphia Exhibition, and Sir William Thomson's report, the following interrogations were put by Mr. Hemming.

You remember Professor Watson, he was associated with you in Philadelphia as a judge of these things?—Yes.

I suppose you had conversation with him on the subject?—Yes.

You remember there was a report at the Centennial Exhibition in which you joined on subjects of this kind?

Mr. ASTON: Which number?

Mr. HEMMING: I only ask Sir William Thomson as to his own knowledge now, I do not put in anything now. You did join in a report on the subject, did you not?—I did not join in a report on the subject, because I wrote it without consultation with anybody.

And did it contain this in describing this instrument?

Mr. ASTON: My lord, I want to know under which objection this reference is contained?

Mr. HEMMING: At present I do not put it in as an anticipation, but Sir William Thomson tells me what he thinks Bell meant, and what he thinks he understood him to mean in America, and I refresh his memory by reminding him of what he said in America. If we make it in anticipation well and good.

Mr. JUSTICE FRY: It seems to me legitimate.

Mr. HEMMING: I may ask him what he said in America?

Were these words in your report:—"A thin circular iron disc held pressed against the end of the tube by the electro-magnetic attraction and free to vibrate through a very small space without touching the central pole, constitutes a sounder, by which the electric effect must be converted into sound." Do you remember that?—Yes.

Would you describe the disc as a disc held pressed against the end of the tube by electro-magnetic attraction?—Yes.

That was your view at that time?—That was my idea of it at that time, which was a few days after I left Philadelphia, and entirely out of my own mind remembering what I had seen, and what I believed I had perceived in trying to hear the words.

That was after Bell had made the instrument speak Shakespeare and my friend says not city, but there was a good deal of city, about steamship, and the 4th July. After all that was done the conviction in your mind then from what you had seen, and what Mr. Bell told you, was that that was to be held down by magnetic attraction?—I believed so, because I believed the best degree of pressure of the ear was that which I remembered when it was caused to press and to be held in that way.

That is what you thought?—Yes.

Do you tell me you think Bell meant it to be cocked up after you made that report, and before you came back to this country; did Bell tell you that is a mistake in your report?—Bell never saw that report; I do not suppose he saw it for months afterwards. It was sent in in writing by post from Niagara. It cannot have seen the light, I should think, till at least the end of the year, probably not till the beginning of the next year.

Whether, with reference to that report or not, did Bell, after that exhibition at Philadelphia, ever say anything to you——

Mr. JUSTICE FRY: I do not understand Sir William saw him after the exhibition in Philadelphia?—I saw him at Boston.

Mr. HEMMING: At the moment of sailing.

You do not mean at the moment of sailing Bell told you this must be always kept cocked up?—He gave me the instrument, as near as I can recollect, in a brown paper parcel, and when I opened the instrument I derived the impression that he did mean the instrument to act in the way my report said it acted.

I do not ask you what impression you derived; but did he tell you it was an essential part of his invention that it was to be kept up?—Yes.

It is inference; but I think you said this, too, did you not, perhaps in a moment of enthusiasm at Philadelphia, when the instrument repeated those newspaper passages as well as the Shakespeare passages, "The thing is done?"—Yes.

You thought the instrument was complete? I do not want to pin you to words.—I thought there was an enormous way to be gone before it was made into a practical useful instrument, and I had reason to think so because of the exceeding difficulty we had in hearing the words. It was with the most exceeding silence in the neighbourhood that you could hear the words at all, and I do not think any one, except Mr. Watson and myself, heard. Other people tried and they could not hear; but we were exceedingly anxious to hear, and took every precaution for silence, and held the instrument exactly in the way which seemed to bring out its sensibility, and I heard distinctly myself. The instrument I felt was not a complete instrument.

Suppose we take the screw out and hold it in that way, would not it work?—It is very probable it might work better than the Glasgow instrument would have worked.

Or, if you put it so, do you think it would work?—I do not know. Very probably, with a proper transmitter.

There is no doubt that, as the telephone said in Philadelphia, "there is the rub." You had not a very proper transmitter when trying experiments on that receiver?—Yes.

We are going to try it with a proper transmitter, that would be the right thing to do?—It will be an interesting experiment.

When asked whether if a Reiss receiver were used with a good transmitter one could hear articulate speech, the witness replied that articulate speech might possibly be heard with it, but the screw employed to regulate the movements would give a very great buzzing, and interfere with articulate speech. When asked what was the new invention of Bell superadded to the gold-beater's skin arrangement when he took out his patent, the witness replied: One very important addition was dispensing with the battery in the line wire in the main wire, in connection with a transmitter operating by a to-and-fro motion in the neighbourhood of a magnet. He substituted permanent magnets for electro-magnets, but not simply permanent magnets for electro-magnets, but permanent magnets with electro-magnetic pole-pieces additional. Another difference was that of the metallic disc instead of the gold-beater's skin, and the witness considered these very important new inventions, and he did not think there was any diminution from the value of the discovery that it was so simple.

Mr. Hemming then read the following extract from THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW of October 1st, 1876:—

There is an article there called "A Summary of Electrical Science at the British Association," that was the Glasgow meeting, and it begins by stating what you said, which I will not read again. It is rather condensed here, but that does not matter. It says, "With this instrument"—that was Bell's instrument—"Sir William Thomson heard the words, 'To be or not to be,' 'There's the rub,' and 'The Americans in London have resolved to celebrate the coming 4th of July,' as well as other sentences involving still longer words which were shouted into a mouthpiece or transmitting instrument of the simplest possible construction." "It," that is the transmitting instrument, I understand, "consists of a membrane stretched vertically across a circular frame of brass, and carrying at its centre a thin oblong piece of soft iron, which vibrates with the membrane in front of the poles of a horse-shoe electro-magnet fixed in a horizontal position, and having its wire in circuit with the receiving instrument or telephone, which is nothing more than a vertical iron-encased electro-magnet (similar to those which formed the subject of a paper by Mr. C. V. Walker, read before the Society of Telegraph Engineers in December last), and having an armature of sheet iron of the thickness of cartridge paper screwed at its edge to the top of the outer casing, but touching it at no other spot." That is a description of the instrument as you described it.

Mr. JUSTICE FRY: That does not add anything to what we had before.

Mr. HEMMING: And then he goes on, and this is the bit I want to call attention to.

Mr. JUSTICE FRY: This describes it in substantially the same way as that given in the *English Mechanic*.

Mr. ASTON: Yes, but it confirms the view I present to your lordship, and the last three lines are very material.

Mr. JUSTICE FRY: I will hear you by-and-bye.

Mr. HEMMING: "The vibrations of the membrane due to the voice cause the soft iron inductor to vibrate in front of the electro-magnet, thus inducing a set of induced currents in the wire surrounding it, and therefore in that of the receiving instrument at the distant station; and a corresponding vibration is set up in the thin plate of iron or armature, sufficient to produce sonorous vibrations audible to the ear by which articulated words can be distinctly recognised. The essential peculiarity in this instrument, and that which makes it differ from previous attempts to obtain the same result, consists in the fact that the communicated vibrations are not only synchronous with those of the transmitting membrane, but they are at the same time similar in quality due to variations in the amplitude, and therefore to the inductive influence of the vibrating inductor."

That having been published before the patent, and the article to which your attention was before called having also been published by the patent, did not people know then that an iron disc would work in the Bell receiver with an electro-magnet?—With an electro-magnet in the line of the main circuit which is essential to that description.

The novelty which Bell really introduced after these publications was this: he found out as his discovery that an iron disc would work without having the battery current in the main line?—That an iron disc would work by a magnet whose magnetism is varied by varia tions of current in the main line; the mode of varying the degrees of magnetisation of a magnet by to and fro undulatory currents in the main line is one important novelty invented by Bell.

Coming back to the Bell receiver, the witness said, one most important part of the new invention is the fixing of the vibrating iron plate all round its edge; that is a most important part, perhaps the most important part of all. He admitted that the disc held at one point of its edge was made known before the date of this patent, and the new invention included the substitution for the disc held at one point of a disc held all round its edge. The witness was here examined at great length on the subject of the relative conductivity of various materials. When asked if it was correct to say that carbon in any form alters its conductive power very greatly by slight alterations of pressure, the witness said, "The subject has been one of recent investigation. I believe Professor Silvanus Thompson or Mr. Tomlinson made some experiments, and found that carbon varies but very little in its resistance under pressure. This quite agrees with my own previous conception on the subject.

Mr. HEMMING then questioned the witness as follows:—

Mr. HEMMING: If I understand rightly—to go back to it—at the date of the patent in 1877, your view is that the effect of pressure on carbon, or other semi-conducting substances, was not a matter of scientific knowledge as regards their conductivity?—So much so, that instantly on hearing of Edison's discovery, I made a telephone, founded on my own investigations. I made one in which the resistance of a copper or iron wire was varied by tension. I used a copper or iron wire, as in the toy telephones. I passed an electrical current through it, and by varying the resistance in that wire by tension, I produced a telephone; but I did not consider it to be of any value whatever. That was one in which the resistance was changed by pressure or tension acting on the internal quality of the substance. I have not varied my opinion as to the nature of the effect of Edison's method, which was by a carbon button, as I understood—my under-

standing of the subject being principally derived from a lecture given by Mr. Preece, at the British Association meeting at Plymouth.

It is no reproach to anybody to have modified his view, especially on such a subject as this: but did not you, as late as February, 1882, explain the matter in this way? I am referring now to an affidavit of yours in this cause—paragraph 9. You say, "One of the best substances that can be employed to form the electric tension regulator is carbon in any of its well-known forms—plumbago or coke carbon or lamp-black. Carbon in all these forms possesses to a remarkable degree the property of greatly varying its resistance to the passage of an electric current under slight changes of pressure."—I have no doubt I used those words.

"It is this property which makes it specially suitable for the purpose for which Edison uses it—as the variations in pressure, being the result of the air undulations caused by the voice, must necessarily be slight, and in order to have a satisfactory telephone it is necessary that the variations in the strength of the current should be sufficiently marked to produce effective vibrations of the diaphragm at the receiving station, or the resulting sounds will not be strong enough to be audible." That was your explanation of the action at that time?—Yes, but at that time I also expressed an opinion that it was variation of surface of contact, and in making that statement I considered that I had previously said that carbon compressed into sticks——

Mr. WEBSTER: Read the whole of that paragraph.

Mr. HEMMING: I did not know there was any more—I will read on: "The carbon may be used either in a solid or in a powdered form. The essential requisite is that the carbon or other material used shall be so adjusted in relation to the contiguous portion of the circuit that, on the one hand, no actual separation shall take place when the diaphragm is vibrated, and on the other hand that they shall not be so tightly and rigidly held together that the vibrations of the diaphragm can produce no effect on the contacts. If an actual separation of the parts takes place, then the circuit is broken, the current is interrupted, and the clearness of articulate speech is thereby impaired. If, on the other hand, there is no variation in the pressure of the contacts, there will be no variation of the resistance, and the current remains of uniform strength, and again no effect is produced by the voice." You say the effects will be, if you get a break it will not do, and if you get so much pressure that you get no variation in the pressure at the contact that there will be no variation in the resistance; but I do not see there that you suggest an alteration of the area of the contact, or an alteration of the number of points of contact, is a *modus operandi*. I should have read that as suggesting that the real *modus operandi* is this, that you get pressure; and very little alteration of the pressure makes a very little alteration in the conducting power of the materials; and that that is true generally of all carbons.—In another part of my evidence I expressed a very strong opinion, partly supported by some experiments of my own, that the cause was the change of area of contact.

When you say another part of your evidence, do you mean another part of the affidavit?—Another part of the evidence I gave in Edinburgh.

I am not referring to Edinburgh at all. I am referring to a much later date.

Mr. JUSTICE FRY: It does not explain in detail what the *modus operandi* is. It does not suggest that increase of pressure varies the current at all.—I do not suppose that in an affidavit I could have expressed an opinion as to the physical principle of the *modus operandi*.

Mr. HEMMING: If it depends on the common quality of all carbons it is material; if on some and not on others, it is different. The suggestion is that it is a common quality of all forms of carbon of having the resistance greatly modified by pressure, and that would make the various forms of carbon group together as good things; and that opinion Sir William does not entertain now?—You mistake me if you think there is any change of opinion.

Mr. JUSTICE FRY: I think you must confine yourself to the question now before us. You had better put the question simply. I know in this sort of case the questions sometimes assume an argumentative form.

Mr. HEMMING: You say you have made some experiments as to the effect of pressure on the conductivity of carbon?—Not of the conductivity of carbon, but a much better conductor than carbon.

What substance?—I experimented thirty years ago, or twenty-five years ago, on copper and iron, and found exceedingly minute changes—changes of a fraction per cent.—changes comparable with the change of length of the wire. I have experimented upon the resistance of contact, which is the thing in question. It is carbon contact which is referred to in my affidavit. It is carbon contact that is so notably affected by these changes. And I have experimented upon metals to find what the nature of the substance was on which depended the peculiar quality of carbon being greatly influenced by these changes of pressure. My opinion has long been, because it was of the pure conductivity of the carbon, that the difference between a contact at a mere point and contact over an area makes so great a difference in the whole resistance. But if that difference depends at all on the conductivity of the substance it must be felt, although in a less degree, in metal. I have experimented in copper and brass. I experimented more particularly on copper—copper globes or half globes solid, and a rigid copper plate; and I find that when carefully cleaned and pressed together I get a definite resistance between the two, tested by wires soldered to the two plates about two or three tenths of an inch from the small surface of contact. I found that when I apply pressure and increase the pressure I get a continually diminishing resistance; when I reduce the pressure I get a continually increasing resistance. There is a difficulty in obtaining definite numerical results, but I have no doubt from what I have seen that the effect depends wholly on the area of the interface between the two; the effect would be greater than that in carbon because of its semi-conductive power.

You have experimented on nothing except copper; is that so?—I made no measurements.

Mr. JUSTICE FRY: These experiments have been subsequent to the year 1877?—Yes, they were made, my lord, last November, and I have made them slightly at various times from year to year.

Mr. HEMMING: You never tried any experiments on carbon?—I never made a single measurement of the resistance of carbon.

Did not the resistance in this Edison apparatus suggest it would be a good thing?—I never made any telephonic investigations at all since the trial at Edinburgh.

The witness continued to say that before Edison's time it was perfectly well known that you could change the electrical current by means of a tension regulator, but Edison claimed its application to transmit voice and speech.

In reference to the part the tympan plays in the various transmitters shown, the following incident occurred:—

Now take Hunnings. Does not the piece of foil in that simply take the place of the Edison piece of foil, and perform the same function of conducting the current and substantially nothing else?—It performs also the function of pressing with firm pressure against the carbon part.

And do you really think that in the action of the Hunnings instrument that foil has any essential functions whatever, except conducting the electricity?—Certainly.

Suppose you took that foil away, and only got sufficient means of carrying the electricity into a heap of coke carbon, would not the instrument work just as well without the foil?—No; this would not work at all.

Look at this. I have made a thing here; this is not an actual instrument. There are two plates of brass.

Mr. JUSTICE FRY: Is this something new? Is this a new exhibit?

Mr. HEMMING: This is a new exhibit.

You see two plates of brass which are connected with two different poles of the battery?—Yes.

They are some little distance apart, and over the gap is a heap of our coke carbon?—Yes.

Do not you suppose that would speak?—I think very likely.

Just as well as ours?—I do not know whether as well or not. I do not know what you call yours.

That Hunnings which you have got. That is the nearest approach we can make to a Hunnings in principle, with something which shall perform the conducting functions, but without anything which anybody can pretend to be a tympanum?

Mr. JUSTICE FRY: I do not understand this.

Mr. HEMMING: Does your lordship see the heap of charcoal?

Mr. JUSTICE FRY: Yes.

Mr. HEMMING: And the two brass plates? The current goes from one brass plate to the other through the little fragments of charcoal, and of course there is a good deal of resistance in the passage. The amount of that resistance is varied, not by a tympan acting on the charcoal at all, but by the air waves themselves acting. The air waves themselves joggle the little bits of charcoal about and alter the number and nature of the points of contact and so alter the resistance. That is the way it must act in that, and what I am putting to Sir William is——

Mr. JUSTICE FRY: You say this might speak although it has no tympanum?—It has a tympan, my lord.

Where is the tympan?—The tympan is that large surface which you are looking straight at; the top surface of the wood and brass.

The joint?—The top surface of the wood and brass is put into a state of vibration. That increases and diminishes the pressure of every particle of carbon upon the metal. I tried an experiment which I very well remember. It was placing little two-legged or three-legged objects upon the sounding-board of a piano, and when the piano was played they all danced. That is the telephone now in court, the result being due to the motion of the platform on which the whole stands.

Instead of there being a direct pressure by the coke or other surfaces above, this would operate by this board moving like the board of the piano and setting in motion the minute particles of carbon?—Yes, clearly, my lord, that board is the tympan.

Mr. HEMMING: I quite follow you, Sir William, and I will not ask you any more about that. Take the tympan off please.

Re-examined by Mr. ASTON.

The witness in reply to a question as to whether on the 9th of December, 1876, the use of a metal diaphragm in the manner described in Morgan-Brown's specification was new for a transmitter, replied—yes. He also gave the same answer in reference to the receiver, and gave as his opinion that the substitution of a metal diaphragm for a membranous diaphragm was decidedly a great improvement. The witness considered that at the date of Edison's patent the combination of a closed circuit with a diaphragm—the same conductive material acted upon by the pressure of the diaphragm—so as to produce variations in the strength of the current by variations of resistance in the line was quite new. Edison only distinctly mentioned two methods of varying resistance in his patent—namely, by the to and fro motion of a metallic conductor with a conductive liquid between, and the carbon method. Edison in all cases specified that the change of resistance would depend upon pressure. With regard to Hunnings transmitter, Sir William said that the use of lamp-black or powdered coke would answer equally well with finely-powdered carbon—in fact, the materials would act precisely in the same way, irrespective of the size of the particles.

Dr. John Hopkinson was next examined by Mr. Moulton. Witness considered the novel features in Bell's patent were the use of a plate diaphragm and the use of a permanent magnet, instead of an electro-magnet excited by a battery in the single circuit of the line wire, or instead of that permanent magnet its obvious equivalent, an electro-magnet excited by a battery which has nothing to do

with the line wire; these were the two sole points of novelty. The apparatus exhibited by Sir W. Thomson at Glasgow was not, in his opinion, identical with the apparatus described in Bell's specification, as it has a greater degree of freedom. The apparatus shown by Sir William Thomson was not, in his opinion, sufficient to instruct an ordinary electrical workman to construct a telephone; it would in fact put him wrong. Tension regulators, in which the material was comparatively solid, and also in which the material was in pieces, were both described by Edison in his specification, compressed plumbago on the one hand, and a tuft of silk with plumbago mixed up in it on the other hand, being mentioned. Although Edison referred to "surface contact," his description was such as to infer that he considered the semi-conductivity of the material employed to be an essential in his tension regulator.

The Hunnings transmitter he considered fell within what Edison describes as a tension regulator. Both the Cox-Walker and the Hickley receivers he thought were substantially the same as the invention described in the Morgan-Brown patent. Cross-examination was then made by Mr. Hemming.

Dr. Hopkinson thought that tongue vibration, which was what took place in the instrument exhibited at the British Association meeting at Glasgow, was objectionable for transmitting; tympanic vibration was required. The fact that a piece of flexible resilient metal held all round the edge would respond to the human voice was, to the best of his knowledge, altogether new. The platinum foil regulator, described by Edison in his patent, was next considered, the evidence of the witness being much to the same effect as that of Sir Frederick Bramwell.

In answer to Mr. Hemming's question whether "a variation of resistance could be produced by speaking against the granules of carbon," the witness thought that but little useful effect would be obtained; if lamp-black were employed no effect at all would result. At the present time it was very doubtful precisely how much is due to what is called external pressure and how much to internal. The success attending an experiment with particles of gas carbon was due, the witness considered, to the action of the sounding-board beneath it; if a lump of clay or putty were substituted for the board little effect would be produced.

Re-examined by Mr. Moulton, the evidence had reference chiefly to the action of currents in an induction coil.

Mr. John Imray was next sworn and examined by Mr. Aston. He said he had been a consulting engineer and patent agent for the last fifteen years, and knew most of the inventions relating to electrical matters. He was well acquainted with Morgan-Brown's specification, and he did not know of any apparatus prior to the date of Bell's patent which would reproduce articulate speech. This witness also described how he had constructed a pair of Bell telephones, which acted well, by the knowledge he gained in reading the specification. Putting himself in the position of an observer at the time of the British Association meeting at Glasgow, the witness stated that the instrument there shown (and now generally known as the Glasgow receiver) would in his opinion have sounded as a free reed, giving a musical tone only. In response to Mr. Aston the witness said he was well acquainted with Edison's specification of the 30th July, 1877. Mr. Aston here quoted a statement from this specification, which reads as follows:—

"I find that it is not practical to open and close the line circuits in instruments for transmitting the human voice; the circuit of the line must always be closed and the transmission be produced by a rise and fall of electric tension, resulting from more or less resistance in the line. This resistance may be produced in several ways. I have shown several which will hereafter be named."

The witness stated that this use of tension regulators as described was new at the date of Edison's patent, and that he was unaware of a closed circuit being employed wherein the electric resistance was varied by the action of a tympanum affecting a tension regulator such as described by Edison and prior to such date. He thought the regulators as claimed by Edison were of two classes, one in which the tension regulator is itself, to a certain degree, elastic or resilient, so that it shall always come back after being pressed, and the other hard and unyielding, but supported by a spring or its equivalent, and that the material employed in any case must be of an imperfect conducting material. In reply to Mr. Aston's question as to whether gas-retort carbon would be used as a tension regulator in the manner described by Edison, the witness said, "Certainly, it is a most suitable material for that." He also stated that plumbago, lamp-black, and powdered gas-coke would answer equally well for tension regulators in the manner described by Edison, and that they all amounted to the same thing practically.

It was, however, well known that different forms of carbon could be made more or less conductive before the date of the patent. Mr. Aston here called the witness's attention to the following extract from Edison's specifications:—"In some cases I make use of a variable resistance resulting from greater or less intimacy of surface contact, such as would result from a disc covered with plumbago placed adjacent to a diaphragm, also covered with plumbago or other semi-conducting material, so that the proximity or extent of surface contact will produce rise and fall of tension, the respective parts being in the telegraphic circuit." The witness declared that the impression such a statement would convey to the minds of electricians in 1877, that you need not put the thing in powder and squeeze it up bodily, but that you might have two hard, or nearly hard, surfaces of carbon, and the closer you brought them together the better they would conduct. In examining the Hunnings transmitter, the witness spoke at considerable length, and gave it as his opinion that as regards the actual working of this instrument and that of Edison the same operation took place, and as to the result and means employed, they were precisely the same. In respect to Cox-Walker's receiver, and with reference to Bell's modification (fig. 31), the witness stated that both instruments were constructed practically in the same way, and that the Hickley receiver was within the terms of Morgan-Brown's specification wherein occurs the passage, "one, two, or more magnetic poles with coils may be placed near a plate to intensify the effect."

In the cross-examination of this witness by Mr. Pearson, he admitted all the well known facts concerning the toy-telephone, and in answer to Mr. Justice Fry said that the Hunnings transmitter was a simplification of Edison's.

Re-examined by Mr. Aston on the same point, the witness said that the platinum plate in the Hunnings transmitter acted in the same way as the diaphragm cork and platinum foil of Edison's transmitter combined. Referring again to the toy-telephone he said that prior to the 9th of December, 1876, he had not heard of a metal diaphragm being used for transmitting articulate sounds by means of electricity.

Mr. John Stevenson Holt (a formal witness) gave evidence as to the contents of some bottles containing graphite, powdered coke, plumbago, &c. In cross-examination by Mr. Hemming he stated that the Blake transmitter was that commonly used by the United Telephone Company.

Mr. Edward Hibbert Johnson, examined by Mr. Webster, stated that he became acquainted with Mr. Edison in 1870, and had continued to work with him ever since; that he was Edison's practical representative with the telephones, and that the branch of work which came under his immediate superintendence was the engineering department, putting the instruments into practical operation, and everything pertaining to the practical work. He stated that Edison began to work at the telephone, as it is now known, in 1876, but had experimented for some years previously in acoustic telegraphy. He was well acquainted with the various forms of transmitters described in Edison's English specification, and the practical working of the various kinds. He had successfully used the tension regulator of plumbago on silk, lamp-black in powder, plumbago in powder and lumps, and they had all worked. Witness certainly did not think it required fresh invention to construct a similar telephone with powdered coal (? coke). Speaking generally, he had tried every form of tension regulator mentioned by Edison, and he had had a large share in the preparation of the specification. All the regulators described will transmit articulate speech. Speaking as an electrician, he considered the Hunnings transmitter identical with that of Edison; they effected the same operation, and obtained the same result by the same means. He considered that with the ordinary electrical knowledge in 1877, and the directions given in Edison's specification, it did not require more than that electrical knowledge to construct the Hunnings transmitter. There was no electrical difference between the powdered gas-coke, the powdered plumbago, or the powdered lamp-black. The witness then described fully to Mr. Justice Fry the Blake transmitter, and said that this transmitter was fully described in Edison's specification. Therefore, although the United Telephone Company are using the Blake transmitter, it was something which in his opinion was described in Edison's patent. He considered Mr. Edison's discovery was new, and added that there was not a tension regulator at the present day in practical use anywhere but which uses carbon in some form or other.

Cross-examined by Mr. Hemming, he said that the Edison carbon button transmitters were first introduced into England in 1879, and they were used very extensively, but every part was made in America. The witness was then questioned at great length on the suject of one of Mr. Edison's receivers, in which he uses the rotating chalk cylinder. Being asked whether there had been any commercial use attached to the methods described in Edison's specification, the witness said he brought over two thousand of them over to England himself. The witness admitted that other tension regulators than those of Edison's, outside his inventions, had been theoretically suggested, but were practically useless. He then explained at great length his own ideas on the different forms of carbon, saying that there would be electrical differences theoretically but not practically, considering the small mass of the active material in the telephone. He stated that the Blake transmitter works with an Edison carbon button, and that Blake in his patent only claims the working parts; he expressly disclaims the use of carbon. In answer to a question as to whether a lump of metal would answer for the Blake or Edison transmitter, he said he had never found it do so, and that fragments of metal would only answer to a certain extent. Re-examined by Mr. Webster with regard to the Blake transmitter, he again said it was the same as shown in Mr. Edison's, figures 10 and 16. Figure 16 was identical. Figure 10 differed only in the fact that it had two electrodes instead of one. He knew that the Blake transmitter had been the subject of litigation in England, the Bell Company as distinguished from the Edison Telephone Company employing them. The examination of this witness completed the case for the plaintiffs, and after some discussion between Mr. Justice Fry and the counsel engaged, respecting the recent Scottish trial, Mr. Webster read the judgment of Lord M'Laren (see ELECTRICAL REVIEW special report).

The defendants' case was opened by Mr. Pearson, Q.C., whose speech occupied a portion of the following day. The first witness called on this side was Mr. Herbert John Allison, the librarian of the Great Seal Patent Office, who gave evidence as to the dates on which certain United States specifications and other papers were received, and publicly exhibited here. Mr. Hunnings was next sworn and examined by Mr. Hemming. This witness was followed by Mr. Thomas Augustus Watson, of Boston, who was associated with Professor Bell during the time he made his telephonic experiments. Professor Silvanus Phillips Thompson's evidence then brought to a close the proceedings of the seventh day. We purpose in our next to commence from the opening speech above alluded to, and to give the chief points brought out therein, and also in the examination of the various witnesses.